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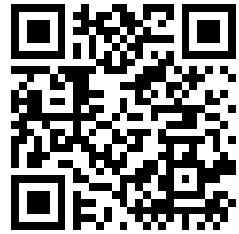

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Cambridge

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Army Entrance Regulations:—

R.M. Academy. Admission to, and for First Appointments therefrom to the Royal Artillery and Royal Engineers, during the period of the War. 1915. Provisional. 1*d.* (1*d.*)

R.M. College. Admission to, and for First Appointments therefrom to the Regular Army, during the period of the War. 1915. Provisional. 1*d.* (1*d.*)

Militia and Imperial Yeomanry. Officers of. 1907. 1*d.* (1*d.*)

Special Reserve of Officers, Malta Militia, Bermuda Militia, Channel Islands Militia, and Territorial Force. Officers of the. 1912. 1*d.* (1*d.*)

University Candidates. 1912. 1*d.* (1*d.*)

Military Forces of the Self-governing Dominions and Crown Colonies. Officers of the. 1912. 1*d.* (1*d.*)

Warrant Officers and N.C.O. of the Regular Army. Combatant Commissions as Second Lieutenants. 1914. Provisional. 1*d.* (1*d.*)

See also Commission; Medical Corps; Special Reserve; Territorial Force, Veterinary Corps.

Army List. The Quarterly (*not issued in* October 1914). Each 15*s.* (10*s.* 9*d.*)

Army Pay, Appointment, Promotion, and Non-Effective Pay. Royal Warrant. 1914. 6*d.* (7*d.*)

Army Allowances Regulations. 1914. 6*d.* (6*d.*)

Army Review. Quarterly. July 1911 to October 1914. 1*s.* (Up to July 1914, 1*s.*; Oct. 1914, 11*d.*) (*Publication suspended.*)

Army Service Corps:—

Regimental Standing Orders. 1911. 6*d.* (6*d.*)

Do. Amendments. 1*d.*; A.S.C. Memorandum, No. 25. 1*d.* (1*d.*)

Training. Part I. 1909. (Reprinted, with Amendments, 1915). 9*d.* (9*d.*)

Do. Part II. Supplies. 1909. (Reprinted, 1914, with new Appendix XII.) 1*s.* 3*d.* (1*s.* 1*d.*)

Do. Part III. Transport. 1911. (Reprinted, with Amendments to April 1915). 9*d.* (9*d.*)

Do. Part IV. Mechanical Transport. (*Out of print*)

Artificers. Military. Handbook. 10th edition. 1915. 9*d.* (9*d.*)

Artillery at the Picardy Manœuvres in 1910. Translated from the French. 2*s.* 6*d.* (2*s.*)

Artillery. Royal:—

Officers' Mess Management. (*See* Ordnance College.)

Practice Instructions—

Garrison. Coast Defences. Seawards. 1914–15. 3*d.* (3*d.*)

Garrison. Siege and Movable Armament. 1914. 3*d.* (3*d.*

Horse, Field, and Heavy. 1914. 6*d.* (5*d.*)

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Artillery. Royal—*continued.*

Standing Orders for—

Brigade of Mounted Artillery. 1*d.* (1*d.*)

Lieutenant-Colonel's Command, R.G.A. (Coast and Siege). 1*d.* (1*d.*)

Training—

Field. 1914. 9*d.* (9*d.*)

Do. Examples of Ranging. To supplement those given in Sec. 227. 2*d.* (2*d.*)

Garrison—

Vol. I. 1914. 6*d.* (6*d.*)

Vol. II. (Siege). 1911. (Reprinted, with Amendments, 1914). 9*d.* (8*d.*)

Vol. III. 1911. (Reprinted, with Amendments, 1914). 1*s.* (11*d.*)

Artillery College. Reports upon the 14th to 18th Senior Classes. Each 1*s.* (9*d.*) (*See also* Ordnance College).

Artillery. Field. The Tactics of. (*Von Schell*). Translated. 1900. 1*s.* (10*d.*)

Artillery Instruments. Handbook of. 1914. 1*s.* 6*d.* (1*s.* 4*d.*)

Do. Amendments. 1*d.* (1*d.*)

Do. Addendum to. 2*d.* (2*d.*)

Do. Appendix. Dec. 1915 (Periscopes, &c.); and Amendments to p. 111 of the Handbook. 1*d.* (1*d.*) (*In the press*)

Artillery Museum in the Rotunda, Woolwich. Official Catalogue. 1906. (*Sold at the Rotunda.* 1*s.* 6*d.*)

Artillery and Rifle Ranges Act, 1885, and Military Lands Acts, 1892 to 1903. Byelaws under:—

Aldeburgh, 1896; Ash (Aldershot Camp), 1887; Finborough, 1901; Hythe, 1894; Inchkeith Battery, 1896; Kinghorness, 1896; Landguard, 1887; Lydd—Dungeness, 1895; Middlewick, 1890; Millbrook, 1888; Orchard Portman, 1896; Scarborough, 1902; Scraps Gate, 1886; Shoeburyness, 1895; Southwold, 1896; Strensall, 1900; Wash, 1891; Whitehaven Battery (Cumberland), 1896. Each 1*d.* (1*d.*)

Purfleet, 1911. 1*s.* (9*d.*)

Salisbury Plain, 1900. 4*d.* (4*d.*)

Artillery Store Accounts and the Supervision of R.G.A. Sub-Districts. Notes on. 1914. 1*s.* (10*d.*)

Artillery Store Accounts and the Care and Preservation of Equipment of Royal Artillery, Horse, Field, and Heavy Batteries. Notes on. Sept. 1914. 6*d.* (5*d.*)

Austria. Campaign of 1866 Against. (*See* GERMANY).

Barracks. Care of. Instruction in. 1901. 9*d.* (7*d.*)

Bashforth Chronograph. Experiments with, to determine the resistance of the air to the motion of projectiles. Report on. 1870. 1*s.* (9*d.*)

Bayonet Fighting. Instruction with Service Rifle and Bayonet. 1915. 1*d.* (1*d.*); Amendments. (*In the press*)

Bayonet Fighting for Competitions. Instruction in. 1*d.* (1*d.*)

Bermuda Militia Artillery. Regulations. 1914. 9*d.* (7*d.*)

Bicycles. Military. Handbook on. 1911. (Reprinted, with Amendments, 1914). 1*d.* (1*d.*)

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British Minor Expeditions, 1746 to 1814. 1884. 2*s.* 6*d.* (1*s.* 11*d.*)
Cadet Units. *See* Territorial Force.
Camel Corps Training. Provisional. 1913. 8*d.* (7*d.*)
Cape of Good Hope. Reconnaissance Survey of the. 1903-1911. Report on the. 1*s.* 6*d.* (1*s.* 1*d.*)
Cavalerie. Translated from the French of Captain Loir. (*In the press*)
Cavalry of the Line. Peace Organization of the; and Arrangements for Mobilization consequent on the establishment of Cavalry Depôts. (Special A.O., July 19, 1909). 1*d.* (1*d.*)
Cavalry School, Netheravon. Standing Orders. 1911. 2*d.* (2*d.*)
Cavalry Training. 1912. (Reprinted, with Amendments, 1915). 1*s.* (11*d.*)
Ceremonial. 1912. 3*d.* (4*d.*); Provisional Amendments, June 1914. 1*d.* (1*d.*)
Chemistry. Practical. Quantitative and Qualitative. A Course of. 5*s.* (3*s.* 8*d.*)
Chemists of the Research Department. Rules and Regulations. 1*d.* (1*d.*)
Chiropody Manual. 2*d.* (2*d.*)
Civil Employment for Ex-Soldiers. Guide to. 1913. 2*d.* (2*d.*)
Civil Employment Regulations. 1913. 1*d.* (1*d.*)
Civil Power. Duties in aid of the. Special A.O., Dec. 17, 1908. (Amendments to "King's Regulations" and to "Manual of Military Law"). 1*d.* (1*d.*)
Clothing and Necessaries (including Materials). Priced Vocabulary of. 1915. Provisional. 1*s.* (11*d.*); Amendments, Jan., 1916. 1*d.* (1*d.*)
Clothing Regulations:—
Part I. Regular Forces (excluding the Special Reserve). 1914. 6*d.* (6*d.*)
Part II. Special Reserve. 1914. 3*d.* (3*d.*)
Part III. Mobilization, Field Service, and Demobilization. 1908. 3*d.* (3*d.*); Amendments to Parts I., II., and III. Nov. 1909, April, Oct. 1910, March, April, Sept., Nov. 1911, Feb., May, July, Sept. 1912, April, July 1913. Each 1*d.* (1*d.*)
Colchester Garrison. Standing Orders. 1913. 9*d.* (7*d.*)
Command. Aldershot. Standing Orders. 1914. 2*s.* 3*d.* (1*s.* 9*d.*) (*Out of print*)
Command. The Art of. By Colonel von Spohn. Translated. 1*d.* (1*d.*)
Command. Western. Standing Orders. Jan. 1910. (Reprinted, with Amendments, 1915). 6*d.* (5*d.*)
Commands, Military, and Staff in the United Kingdom. Reorganization of. (Special A.O., Jan. 6, 1905, with alterations to date. Issued with Special A.O., Nov. 11, 1907). 3*d.* (3*d.*)
Commission in H.M. Regular Army (from 1st April 1912). Short guide to the various ways of obtaining a; &c., &c. April 1912. 2*d.* (2*d.*) (*See also* Army Entrance; Medical Corps; Special Reserve; Territorial Force; Veterinary Corps).
Company Training. Notes on. For the use of the Special Reserve; Territorial Force, and newly raised Units of the Regular Army. Sept. 1914. 1*d.* (1*d.*)
Conveyance of Troops and Issue of Travelling Warrants. Instructions. 1910. 2*d.* (2*d.*)

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Cooking. Military. Manual of. 6*d.* (5*d.*)
Cooking and Dietary. Military. Manual of. Mobilization. 1915. 2*d.* (2*d.*)
Crews of War Department Vessels and Boats at Home Stations. Regulations for the Appointment, Pay, and Promotion of. 1911. 2*d.* (2*d.*)
Cyclist Training. Provisional. 1914. 3*d.* (3*d.*)
Division Orders. Extracts from. 1880. 2*s.* 6*d.* (1*s.* 9*d.*)
Drainage Manual. For the use of Royal Engineer Officers, and other persons, employed on the Construction and Maintenance of Drainage Works in connection with War Department Buildings in the United Kingdom or in similar climates. Revised Edition, 1907. (Reprinted 1915). 6*s.* (4*s.* 4*d.*)
Drawing Plates. Military:—
Attack of Dufor's Countermines or 2nd plate of Mines; Carnot's First System; Detached Forts; Concealed Defences, 1, 2, 3, 4; Printing Plate, A, B, C, &c.; Detail Plate, No. 1; Do. No. 2; Neighbourhood of Woolwich; Village and Surrounding Ground; each 2*d.* (2*d.*)
Attack of Fortress—Preliminary Operations; Do., Distant Attack; Do., Close Attack; Neighbourhood of Metz; each 3*d.* (3*d.*)
Woods and Villages. Six plates. Each 6*d.* (5*d.*)
Neighbourhood of Woolwich. Southern Side. 1*s.* 6*d.* (1*s.* 1*d.*)
Dress Regulations. 1911. 2*s.* 6*d.* (2*s.*) (*Out of print*); **Amendments.** March, Aug. 1912. Each 1*d.* (1*d.*); Aug. 1913. 2*d* (2*d.*)
Drum and Flute Duty for the Infantry, with Instructions for the Training of Drummers and Flautists. 1887. 2*s.* (1*s.* 6*d.*)
Dynamics. Notes on. (*See* Ordnance College).
Egypt. British Force in. Standing Orders. 1912. 1*s.* (10*d.*)
Egypt. Campaign of 1882 in. Military History. With Case of Maps. Condensed Edition. 1908. 3*s.* 6*d.* (2*s.* 8*d.*)
Electrical Communications. Fixed. Instructions as to. 1912. 4*d.* (4*d.*)
Electricity and Magnetism. Text Book for the use of the Cadets at the R.M. Academy. 1911. 2*s.* 6*d.* (2*s.*) (*Under revision*)
Electricity. Notes on. 1915. 1*s.* (11*d.*)
Electric Light Apparatus. Defence. Instructions for the working of. 1915. 1*d.* (1*d.*)
Electric Lighting. Military. Vol. I. 1*s.* (11*d.*); Vol. II. 1909. (Reprinted, with Amendments, 1915). 1*s.* 6*d.* (1*s.* 4*d.*); Vol. III. 1*s.* (11*d.*)
Encounter. The Battle of. By Hans von Kiesling. Part I. Practical. Translated. 1*s.* 6*d.* (1*s.* 3*d.*)
Engineer Services Regulations. Peace:—Part 1. 1910. (Reprinted, with Amendments published up to May 1, 1915). 1*s.* (11*d.*); Part 2. 1911. Technical Treatises. (Reprinted, with Amendments to May 1, 1915). 9*d.* (8*d.*)
Engineer Training. 1912. (Reprinted, with Amendments, 1914). 6*d.* (6*d.*)
Engineering. Field. Manual of. 1911. 9*d.* (9*d.*)
Engineering. Military:—
Part I. Field Defences. 1908. 1*s.* 6*d.* (1*s.* 3*d.*)
Part II. Attack and Defence of Fortresses. 1910. 9*d.* (8*d.*)

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Engineering. Military—*continued.*

Part III*a*. Military Bridging—General Principles and Materials. 1913. 1*s*. (11*d*.); Index. 1*d*. (1*d*.)

Part III*b*. Do.—Bridges. 1*s*. 3*d*. (1*s*. 2*d*.); Index. 1*d*. (1*d*.)

Part IV. Mining and Demolitions. 1910. (Reprinted, 1915, with Amendments to 1912 inclusive). 1*s*. (11*d*.)

Part V. Miscellaneous. 1914. 1*s*. (11*d*.)

Part VI. Military Railways. 1898. (*Out of print*)

Equipment Regulations:—

Part 1. 1912. (Reprinted with Amendments published in Army Orders up to Aug. 31, 1914). 1*s*. (11*d*.)

Part 2. Details—

Sect.

I. Infantry. (Regular Army.) 1913. 6*d*. (5*d*.)

I*a*. Mounted Infantry. 1912. 6*d*. (5*d*.)

II. Cavalry. (Regular Army.) 1914. 3*d*. (3*d*.)

III. Army Service Corps. (Regular Army). 1913. 6*d*. (5*d*.)

IV., IV*a*., and IV*b*. Army Ordnance Corps. Army Pay Corps. Army Veterinary Corps. (Regular Army.) 1914. 2*d*. (2*d*.)

V. Royal Army Medical Corps. (Regular Army.) 1914. 2*d*. (2*d*.)

VI.—IX. R.M. Academy; R.M. and Staff Colleges; Garrison Staff and Schools of Instruction; Military Prisons, Detention Barracks, and Military Provost Staff Corps. (Regular Army.) 1914. 2*d*. (2*d*.)

X*a*. Engineer. General. Fortress, Survey, Railway, and Depôt Units. Peace and War. (Regular Army.) 1914. 2*d*. (3*d*.)

X*b*. Field Troop. (Regular Army.) 1912. 2*d*. (2*d*.)

X*c*. Field Company. (Regular Army.) 1914. 2*d*. (2*d*.)

X*d*. Divisional Signal Company. (Regular Army.) 1914. 2*d*. (2*d*.)

Sect.

X*e*. Signal Company (Wireless). (Regular Army.) 1912. 2*d*. (2*d*.)

X*f*. Headquarters Signal Units. (Regular Army.) 1914. 2*d*. (2*d*.)

X*g*. Signal Company (Cable). (Regular Army.) 1912. 2*d*. (2*d*.)

X*h*. Signal Squadron. (Regular Army.) 1914. 2*d*. (2*d*.)

X*j*. Signal Troop with Cavalry Brigade. (Regular Army.) 1912. 2*d*. (2*d*.)

X*k*. Signal Troop with a Cavalry Brigade not allotted to a Cavalry Division. (Regular Army.) 1914. 2*d*. (2*d*.)

X*l*. Signal Company (South Africa). (Regular Army.) 1912. 2*d*. (2*d*.)

X*m*. Bridging Train. (Regular Army.) 1912. 2*d*. (2*d*.)

X*n*. Field Squadron. (Regular Army.) 1914. 2*d*. (2*d*.)

XI*a*. Horse Artillery. Q.F. 13-pr. (Regular Army.) 1913. 9*d*. (8*d*.)

XI*b*. Field Artillery. Q.F. 18-pr. (Regular Army.) 1914. 9*d*. (8*d*.)

XI*c*. Field Artillery. Q.F. 4·5-in. Howitzer. (Regular Army.) 1913. (Reprinted, with Amendments up to Aug. 1, 1914). 9*d*. (8*d*.)

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Equipment Regulations—*continued.*

Part 2. Details—*continued.*

Sect.
XI*d*. Reserve Brigades with Q.F. 18-pr. Equipment, Horse and Field Artillery, Staff and Depôts, Riding Establishment, School of Gunnery (Horse and Field), and Mounted Band (Regular Army). 1914. 6*d*. (6*d*.)
XI*e*. Mountain Artillery with B.L. 2·75-inch Equipment. Mountain Battery and Ammunition Column. Mule Transport. (Regular Army.) 1914. 6*d*. (5*d*.)
XII*a*. Royal Garrison Artillery. (Regular Army.) 1914. 2*s*. 6*d*. (1*s*. 11*d*.)
XII*b*. Royal Garrison Artillery. Siege Artillery, Movable Armament, and Machine Guns in Armaments. 1913. 1*s*. (10*d*.)

Sect.
XII*c*. Heavy Artillery. B.L. 60-pr. (Regular Army.) 1913. 9*d*. (8*d*.)
XIV. Cavalry School, Netheravon. (Regular Army.) 1914. 2*d*. (2*d*.)
XV. Camel Corps School, Egypt. (Regular Army.) 1914. 2*d*. (2*d*.)
XVI. Special Reserve. 1913. 4*d*. (4*d*.)
XVII. Officers Training Corps. 1912. 3*d*. (3*d*.)
Practice Batteries and Drill Guns (Fixed Mountings) of the Royal Garrison Artillery. (Part 2, Secns. XII*a* and XVI, and Part 3.) 1909. 1*s*. 6*d* (1*s*. 2*d*.)

Part 3. Territorial Force. 1914. 6*d*. (6*d*.)
Do. Details :—
Sec. IX. Artillery. 1912. 1*s*. (9*d*.)
Do. Amendments, April 1912; Feb. 1914. Each 1*d*. (1*d*.)
Sec. X. Engineer. 1912. 3*d*. (3*d*.)
Amendments to Part 2. Feb., April, July (two issues), Aug. 1914. Each 1*d*. (1*d*.)
Amendments to Parts 1, 2 and 3. Nov. 1913. 1*d*. (1*d*.)
Amendments to Parts 1, 2 and 3. March, July 1913; April, Aug. 1914. Each 2*d*. (2*d*.)

Equipment. Infantry. Pattern 1908 Web. 1913. 2*d*. (2*d*.)

European War, 1914-15. Despatches (Naval and Military) relating to Operations in the War :—
I. Sept., Oct., and Nov. 1914. With List of Honours and Rewards Conferred. With Sketch Map. 2*d*. (3*d*.)
II. Nov. 1914 to June 1915, with Names of Officers mentioned, and Awards of the Victoria Cross. 6*d*. (7*d*.)

Examination Papers :—
Qualifying Certificates. Sept. 1905; March 1906; Sept. 1909; March Sept. 1910; March, Sept. 1911; March 1912. Each 6*d*. (5*d*.)

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Examination Papers—*continued.*

Entrance: R.M. Academy, R.M. College, Qualifying Test for Commissions. Supplementary First Appointments in the Royal Marines. June-July 1912. 1*s.* (11*d.*)

Entrance: R.M. Academy, R.M. College, Qualifying Test for Commissions. Nov. 1912; Nov.-Dec. 1913. Each 1*s.* (11*d.*)

Entrance: R.M. Academy, R.M. College, Qualifying Test for Commissions. Supplementary First Appointments in the Royal Marines. Appointments in the Indian Police Force. Appointments in the Police Forces of the Straits Settlements and the Federated Malay States. Cadetships in the Royal Navy (Special Entry). June-July 1914. 1*s.* (11*d.*)

Entrance: R.M. Academy, R.M. College, Indian Army College. Supplementary First Appointments in the Royal Marines. Appointments in the Indian Police Force. Appointments in the Police Force of Ceylon. Cadetships in the Royal Navy (Special Entry). June-July 1915. 1*s.* (11*d.*)

Freehand Drawing at the Army Entrance Examination of Nov. 1913. Specimen Paper to illustrate the kind of questions that will be set in. 6*d.* (5*d.*)

R.M. Academy, Fourth Class; **R.M. College,** Fourth, Third, and Second Divisions. July, Dec. 1904; June 1905. Each 1*s.*

R.M. Academy, Fourth Class; **R.M. College,** Senior Division. Dec. 1905; June, Dec. 1906; July, Dec. 1907. Each 1*s.*

Staff College. Admission. Aug. 1907; Aug. 1909; July 1911; June-July 1912; June-July 1913. Each 1*s.* (6*d.*)

Regular Forces, Canadian Permanent Forces, Special Reserve of Officers, Territorial Force, and Colonial Military Forces. May, Nov. 1906; May, Nov. 1908. Each 1*s.* (11*d.*)
Do. May 1909. 9*d.* (8*d.*)

Officers for Promotion. Dec. 1912; May, Dec. 1913; April 1914. Each 1*s.* (6*d.*)

Militia, Imperial Yeomanry, and University Candidates. March, Sept. 1904; Sept. 1905; Oct. 1906. Each 1*s.*

Special Reserve, Militia, Territorial Force, and University Candidates. Oct. 1911; March, Oct. 1912; March, Oct. 1913. Each 1*s.* (6*d.*)

Special Reserve, Militia, Territorial Force, Non-Commissioned Officers, and University Candidates. March 1914. 1*s.* (6*d.*)

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Examination Papers—*continued.*

Officers Training Corps :—

Cadets of the Senior Division. Certificate A. Dec. 1908. 6*d.* (5*d.*)

Cadets of the Junior and Senior Divisions. Certificates A and B. Spring of 1909; May, Nov. 1911; March, Nov. 1912; March, Nov. 1913; March 1914. Each 6*d.* (6*d.*)

Foreign Languages. Modern. July 1906; July 1908; April, July 1909; Jan., June, Oct. 1910; Jan., June 1911; June 1912; June 1913; June 1914. Each 1*s.* (6*d.*)

Explosives. Service. Treatise on. 1907. 1*s.* 6*d.* (1*s.* 2*d.*)

Field Almanac. 1915. 1*d.* (1*d.*) (*Under revision*)

Field Service Manuals :—

Ammunition Column. Divisional. New Armies. 1915. 3*d.* (3*d.*) (*In the press*)

Artillery. Field. Brigade. Q.F. 18-pr. 1915. 3*d.* (3*d.*)

Do. Do. (Howitzer) Brigade. 5-inch B.L. 1908. 3*d.* (3*d.*)

Do. Heavy. (B.L. 60-pr.) Battery and Ammunition Column. Expeditionary Force. 1910. 3*d.* (3*d.*) (*Under revision*)

Do. Horse. Brigade. 13-pr. Q.F. 1908. 3*d.* (3*d.*) (*Under revision*)

Do. Do. Appendix to. R.H.A. Battery and Mounted Brigade Ammunition Column. 1*d.* (1*d.*)

Cavalry Regiment. Expeditionary Force. 1913. 3*d.* (3*d.*) (*Under revision*)

Engineers. Balloon Company. Expeditionary Force. 1910. 3*d.* (3*d.*)

Do. Bridging Train. Expeditionary Force. 1915. 3*d.* (3*d.*)

Do. Field Company. Expeditionary Force. 1915. 3*d.* (3*d.*)

Do. Field Squadron. Expeditionary Force. 1914. 3*d.* (3*d.*)

Do. Works Company. Expeditionary Force. 1910. 3*d.* (3*d.*)

Headquarters Units. Expeditionary Force. 1911. 3*d.* (3*d.*)

Infantry Battalion. Expeditionary Force. 1914. 3*d.* (3*d.*)

Infantry (Mounted) Battalion. Expeditionary Force. 1913. 3*d.* (3*d.*)

Medical Service. Army. Expeditionary Force. 1914. 3*d.* (3*d.*)

Signal Service. Signal Company (Air-line). Expeditionary Force. 1913. 3*d.* (3*d.*)

Do. Signal Company (Cable). Expeditionary Force. 1913. 3*d.* (3*d.*)

Do. Signal Company (Divisional). Expeditionary Force. 1915. 3*d.* (3*d.*)

Do. Signal Company (Lines of Communication). Expeditionary Force. 1914. 3*d.* (3*d.*)

Field Service Pocket Book. 1914. 1*s.* (11*d.*)

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Field Service Regulations:—
Part I. Operations. 1909. (Reprinted, with Amendments, 1914). 6*d*. (6*d*.)
Part II. Organization and Administration. 1909. (Reprinted, with Amendments to Oct. 1914). 1*s*. (10*d*.)
Do. Amendments, April 1915. 1*d*. (1*d*.)

Financial Instructions in relation to Army Accounts. 1910. (Reprinted, with Amendments to Sept. 1, 1914). 4*d*. (4*d*.)

Flying Corps. Royal. Training Manuals:—
Part I. Provisional. 1914. 1*s*. (10*d*.)
Do. Amendments. Jan. 1915. 1*d*. (1*d*.)
Part II. Military Wing. Provisional. 1914. 3*d*. (4*d*.)

Foreign Languages. Study of. Regulations. 1913. 2*d*. (2*d*.)

Fortification. Permanent. For the Imperial Military Training Establishments and for the Instruction of Officers of all Arms of the Austro-Hungarian Army. 7th Edition. Translated. 4*s*. (2*s*. 11*d*.)

Franco-German War, 1870-71. Translated from the German Official Account:—
First Part—History of the War to the Downfall of the Empire—
Vol. 1 (Secns. 1 to 5). Outbreak of Hostilities to Battle of Gravelotte. (*Out of print*)
Vol. 2 (Secns. 6 to 9). Battle of Gravelotte to Downfall of the Empire. (*Out of print*)
Second Part—History of the War against the Republic—
Vol. 1 (Secns. 10 to 13). Investment of Paris to Re-occupation of Orleans by the Germans. £1 6*s*. (18*s*. 6*d*).
Vol. 2 (Secns. 14 to 18). Events in Northern France from end of Nov. In North-west from beginning of Dec. Siege of Paris from commencement of Dec. to the Armistice. Operations in the South-east from middle of Nov. to middle of Jan. £1 6*s*. (19*s*.)
Vol. 3 (Secns. 19 and 20). Events in South-east France from middle of Jan. to Termination of Hostilities. Rearward Communications. The Armistice. Homeward March and Occupation. Retrospect. £1 11*s*. 6*d*. (£1 2*s*. 3*d*.)

Also separately, Sections in paper covers, and Plans unmounted:—

Section.
1. Events in July. Plan. 3*s*. (2*s*. 2*d*.)
2. Events to Eve of Battles of Wörth and Spicheren. 3rd ed. (*Out of print*)
3. Battles of Wörth and Spicheren. 3rd edition. (*Out of print*)
4. Advance of Third Army to the Moselle, &c. 2nd edition. (*Out of print*)
5. Operations near Metz on 15th, 16th, and 17th August. Battle of Vionville—Mars la Tour. 2nd edition. (*Out of print*)
6. Battle of Gravelotte—St. Privat. (*Out of print*)
7. Advance of Third Army and of Army of the Meuse against Army of Chalons. (*Out of print*)
8. Battle of Sedan. (*Out of print*)
9. Proceedings on German Coast and before Fortresses in Alsace-Lorraine. Battle of Noisseville. General review of War up to Sept. 4*s*. 6*d*. (3*s*. 4*d*.)

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Section—*continued.*

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GARRISON ARTILLERY TRAINING.

VOL. II. (SIEGE), 1911.

In this volume are given technical details as to the employment of siege artillery. The general system of training and the principles of construction of modern artillery and its ammunition are described in "Training and Manœuvre Regulations" and in "Garrison Artillery Training," Vol. I., respectively.

The procedure followed in the case of Movable Armament will, generally, be that laid down for Field Artillery (see "Field Artillery Training"), *with the exception of 6" B.L. Howitzers, which will be worked on Siege Artillery lines.*

CHAPTER I.

Organization and Training of Siege Artillery.

1. *Organization.*

1. Siege batteries will not normally form part of an army in the field, but will, if required, be added as circumstances may demand.

2. The peace establishment of siege artillery comprises a siege artillery brigade of three garrison artillery companies

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two of which are equipped with medium howitzers, and one with heavy howitzers.

Each of the three companies forms the nucleus of two batteries which are organized for war as :—

A heavy brigade of two heavy howitzer batteries.
A medium brigade of four medium howitzer batteries and two ammunition columns.

The heavy siege brigade includes guns and personnel only, provision for moving guns and bringing up ammunition, platforms, &c., being made from other sources.

3. For the heavy siege batteries (and also for such medium batteries employed in a siege, as are not provided with ammunition columns), brigade ammunition depôts will be formed, from which they will obtain their ammunition by rail or tramway. Detached batteries will draw their ammunition from the nearest brigade ammunition depôt.

4. The medium siege brigade is horsed and organized as a mobile unit, the intention being that, in addition to being available for use in a siege, it would be utilized, if required, for work in the field. When thus employed, the ammunition columns—one of which will be formed for every two batteries—will accompany the batteries, and will fill up, as required, from ordnance depôt units.

5. The siege artillery may also be augmented by additional batteries of heavy guns, and by other medium howitzer batteries, manned by personnel detailed from the garrison artillery companies. The details of the establishments of siege artillery are shown in "War Establishments Expeditionary Force."

2. *Training.*

1. The company commander is responsible for the training and efficiency of all officers and men of his company in all

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respects and will be given great latitude in his methods of imparting instruction.

2. It is essential that the different ranks of a company shall receive a thorough training in drill, laying, fire discipline and observation of fire, and that N.C.Os. and men are instructed in the rapid preparation and handling of ammunition, including fixing and setting of fuzes, distinguishing ammunition, and a knowledge of all the service marks.

3. Every non-commissioned officer must be a qualified layer, observer or telephonist.

4. Practice in the selection of observing stations and in combined fire from two or more batteries, particularly in respect of distribution and concentration of fire, is most important.

5. The packing of vehicles will be practised and the uses of the stores pointed out. The employment of stores for purposes for which they are not intended is prohibited.

6. In siege operations, new conditions or difficulties continually arise, and expedients for meeting and overcoming them as they occur must be devised. No fixed rules applicable to all cases are possible, but a knowledge of the principles of employment of siege artillery and frequent practice under varying conditions will enable officers to cope with most of the difficulties that are likely to be met with on service.

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CHAPTER II.

LAYING.

3. *General instructions.*

1. The process of laying a gun or howitzer consists in pointing its axis in such a direction that the projectile will hit the target. This direction is arrived at by giving motion to the gun in two planes: a motion in a vertical plane, termed "elevation," and a motion in a horizontal plane, termed "direction."

2. Elevation may be given to a gun in two ways: by inclining its axis at a given angle with a line of sight to a visible object (the target or an aiming point), or by inclining its axis at a given angle with the horizontal. The former is effected by means of the sights, and is called "direct" laying; the latter by means of a clinometer, and is called "indirect" laying.

The sighting arrangements vary with the nature of gun or howitzer, and are described in the handbooks.

3. Every non-commissioned officer, not debarred by some defect of vision, and any intelligent gunner with good sight, should be capable of qualifying as a layer, if properly instructed.

4. In order to maintain the requisite standard, all layers must be practised regularly under an officer, and all, including serjeants, should be tested periodically. At the annual class firing practice twenty-four trained layers, twelve in each half company, must be produced; a sufficient number

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of extra layers must be trained, therefore, to allow for casualties.

The training of layers must ensure :—

i. A thorough understanding of the manipulation of sights and clinometer.

ii. A knowledge of the method of laying out the line of fire under all conditions.

iii. A uniform system of laying, so that successive rounds even if laid by different layers, may be laid similarly.

All layers will be required to qualify, according to the tests laid down, in such portions of the procedure in laying out the line of fire as devolves upon them.

4. *Methods of laying.*

Direct laying.

1. With howitzers the only occasion when this method will be used will be when firing at balloons, kites, or any other form of aerial vessel.

2. To lay a howitzer or gun direct the layer sets the sight at the elevation and deflection ordered ; he then lays the gun on the target or aiming point by bringing the pointer or cross-wires of the telescope in line with the point aimed at, or in the case of open sights by bringing the top of the notch, the apex of the foresight and the object aimed at, in line.

3. To ensure good laying the following rules must be observed :—

The eyepiece of the telescope to be focussed so that the pointer or cross-wires are clearly seen.

The head to be upright and the body in an easy position

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The eye not to be less than one foot in rear of the tangent sight notch, and the distance between the eye and notch not to be varied from round to round.

The operation of laying to be completed as rapidly as possible, so as not to fatigue the eye.

The most conspicuous part of the object to be chosen to lay on; the ground line should be selected if possible. Should there be any likelihood of one layer laying on a different part of the target to another, and there is no natural ground line, some definite point should be given for the layers to lay on.

The gun to be laid a little above the object, and then depressed on to it; this is to ensure the teeth of the elevating arc being in bearing with the driving pinion.

Indirect laying.

1. The gun is first laid for direction on an auxiliary mark or aiming post (as described in Chapter III), and then laid for elevation.

2. When the sights are set in at an angle to compensate for drift, they must be set approximately at the elevation when laying for direction.

With cross-bar sights, which are set in vertically, they may be set at any convenient elevation, the correction for drift being made by means of deflection.

5. *To pick up an auxiliary mark.*

1. The exact detail of the procedure varies with the means (sights, arc, &c.) available. In general, it is as follows:—

The gun is first laid in the line of fire, as described in Chapter III, and the sights are then moved until they are in

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line with some natural or artificial object sufficiently conspicuous to be readily identified. The readings of the sights are then noted, and the gun is laid for subsequent rounds on the object selected.

2. With dial sights an auxiliary mark may be picked up in any direction.

3. With ordinary tangent sights it will seldom be possible to pick up a natural auxiliary mark. Cross-bar sights and gun arcs give more latitude.

4. When laying on an auxiliary mark to the front or rear it is important that a gun should not become laterally displaced to an appreciable extent after firing, or inaccuracy in the shooting for direction will result; considerable recoil is of small consequence provided it is straight to the rear.

When laying on an auxiliary mark directly to a flank, on the other hand, lateral displacement is of no consequence, but considerable recoil is. In both cases, the further off the auxiliary mark the less the error.

6. *Difference of level of wheels.*

1. If the wheels or platform of a gun or howitzer are not level the shell will travel towards the lower side, unless a correction is made to prevent it.

2. In the case of guns or howitzers not fitted with dial sights this is done by giving deflection according to the following rule:—Multiply the number of degrees difference of level of the wheels or platform by the number of degrees of elevation, the result is the number of minutes deflection to be given towards the higher side. The difference of level is measured by means of the clinometer, after the gun has been roughly laid for line, and it will generally be sufficient to take it to the nearest $\frac{1}{4}°$, and to calculate the necessary deflection to the nearest 5′.

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3. In the case of guns and howitzers fitted with dial sights, the correction is made automatically by levelling the dial plate. This should be done after the gun is roughly laid for line.

7. *Night firing.*

1. When firing by night the guns are laid for direction on lanterns, which are fixed on pickets placed in line with the auxiliary marks.

2. When using dial sights, the pointer must be illuminated by throwing a light across the object glass of the telescope. With open sights, the one furthest from the layer must be illuminated.

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CHAPTER III.

Obtaining the Line of Fire.

8. *General instructions.*

1. Howitzers will normally be fired from behind cover, the elevation being given by clinometer and the direction by laying for line on an auxiliary mark or an aiming post.

2. An auxiliary mark is a natural or artificial object, a considerable distance from the gun, within the scope of the sights when the gun is laid in the direction of the target.

It follows that, when using crossbar sights only, an auxiliary mark must be within about 6° each side of the line of fire; by using the gun arc this is extended to 30° each side; while with a dial sight an auxiliary mark in any direction may be employed.

3. An auxiliary mark should be clearly defined and easily distinguished, and the more distant it is the less will be the error in line due to inaccuracy in laying or to the gun becoming displaced from its original position. Consequently, when firing without platforms it is especially important to select the most distant auxiliary mark available, and as near the line of fire as possible, since with a distant mark, and one near the line of fire, the gun may be relaid and fired from the position to which it recoils, even if that is slightly off the original line of fire, whereas with an auxiliary mark or aiming post close to the gun it is necessary to restore the gun after each round as nearly as possible to its original position.

4. If, owing to confined space or other reasons, an auxiliary mark cannot be employed, aiming posts will be used.

When guns are firing off platforms one will be used for

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each gun, but when firing off the ground it is necessary to plant two aiming posts at least 10 yards apart.

In either case aiming posts should be as far from the guns as space and visibility permit.

5. The pointing out of a target should be done as rapidly as possible, and care should be taken that each man thoroughly understands it and its surroundings.

Any prominent objects close to the target should be noted.

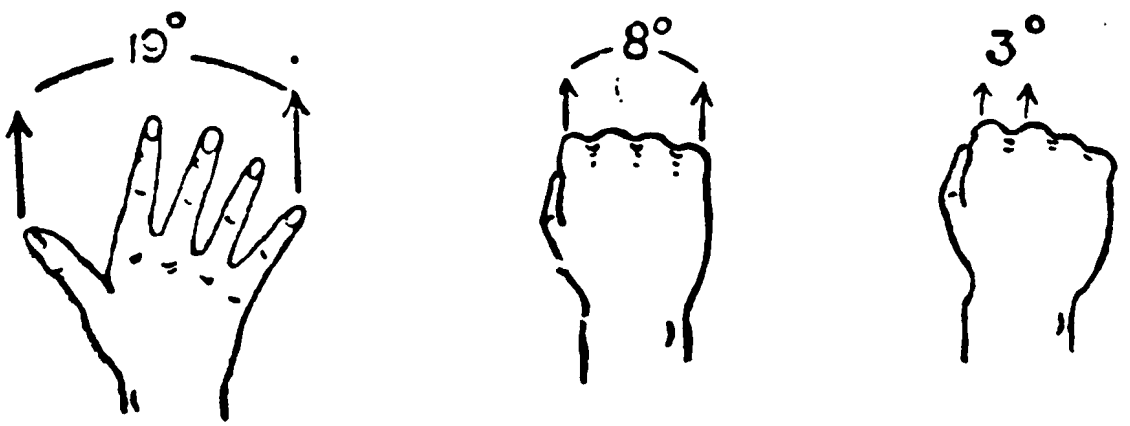
While this is being done the men should keep under cover as much as possible. A convenient way of pointing out a target is to place two sticks or aiming posts in line with it and make each man look over them with field glasses.

A target may be indicated by the clock-face method thus :—

A prominent object is taken as the centre of the clock face and the position and distance of the target in degrees and minutes with reference to that object is described, as, for example, 1 o'clock 20 minutes, 3 o'clock 1° 30′.

6. Angular measurements may be taken with graticuled field glasses or estimated if each individual knows the angles which are subtended by knuckles and other portions of the hand when the arm is held at full length, for example :—

FIG. 1.



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If targets are pointed out through high-power telescopes the men should invariably look at them again through field glasses for the purpose of recognizing adjacent features. It is a great assistance to note objects on the skyline behind targets, but when observers are to move considerably to a flank afterwards they should try to anticipate the relative changes in the positions of objects.

7. In regular siege operations where the guns will probably be in emplacements, and sited to cover a certain arc with their fire, the preliminary operations of constructing the batteries and laying platforms, &c., will enable a line of fire to be laid out on to some reference point in this arc, and the line of fire to any target which it is desired to engage may be obtained by a switch from this reference point.

8. When medium siege howitzers are used in the field it will be necessary, however, to lay out lines of fire accurately and quickly by varying methods, as circumstances permit. These are shown in the following instructions which have reference to the 6-inch howitzers provided with dial sights and directors No. 2. When the dial sight No. 4 is employed, the telescope will be placed so that when the sight is at zero the object glass will be to the front and the reader under the eyepiece.

The variations required by other equipments are dealt with in Sec. **14.**

9. If it is necessary to open out or close lines of fire the order would be "Distribute or Concentrate.....minutes from No....."

If the order is "Distribute 10 minutes from No. 1" no deflection is given to the named gun, but each of the remaining guns would be given 10 minutes left deflection for every gun interval between it and No. 1 gun.

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If the order is "Concentrate 15 minutes on No. 1," no deflection is given to the gun named ; each of the remaining guns would be given 15 minutes deflection for every gun interval between it and the gun named, viz., No. 2 gun 15 minutes more right, No. 3 gun 30 minutes more right, and so on.

8A. *Principles to be observed in obtaining the line of fire.*

1. Parallel lines of fire should always be obtained and the section commander who accompanies the battery commander in his reconnaissance is responsible for this. The battery commander is responsible for giving the section commander sufficient information to enable him to do this.

It is preferable to utilize an aiming point and thereby give one angle to all guns, rather than to give an angle to each gun, which is a slow method and liable to produce errors in parallelism. Besides this latter consideration the giving of individual angles necessitates the guns being in action before any steps can be taken to obtain the line of fire, whereas with an aiming point all angles should be measured and calculations made by the time the guns are unlimbered. The section commander is responsible for the calculation and ordering of all corrections for displacement of the battery from the line of his battery director—target, and, if possible, the corrections for this displacement should be included in the angle ordered from the aiming point. The battery commander is responsible for all corrections for proper distribution or concentration of the fire.

2. The battery commander will be accompanied in his reconnaissance by a section commander ; each of these officers will be provided with a director. The battery

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commander's director will be carried by one of his staff and that for the section commander, which will be referred to as the battery director, will be carried by the section commander's horseholder, or by one of the higher numbers of the gun detachments.

3. The battery commander will indicate the line of the target for the battery director by one of the methods described in Section 8B, and will tell the section commander on to what part of the target the line is given, and on to what part of the target he expects the line of fire of the battery to be. He will also tell him the range to the target as soon as he can. All further responsibility for giving the guns parallel lines of fire on to the required portion of the target will rest with the section commander, and the battery commander need only consider corrections for line necessary on account of the extent of the target, *e.g.*, distribution or concentration, or on account of wind.

8B. *Methods of indicating the line to the battery director.*

The following are the methods by which a battery commander may indicate the line from the battery director to the target :—

i. If the target is visible from ground in front or in rear of the battery position he may plant two aiming posts in line with the target ; the section commander will then set up the battery director in line with the two aiming posts, so that when set at zero the telescope is pointing in the direction of the target. The most favourable position for the battery director is on or near the intended position of the

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battery. This method is quick and has the advantage of causing the minimum exposure to the personnel.

ii. If the target is visible from a point adjacent to the intended position for the battery, the battery commander may himself set up the battery director set at zero and lay it on the target.

This method is convenient when the director is in such a position that the line of fire can be obtained from an aiming point, or when it will be necessary to give individual angles to each gun.

iii. If the target is visible from a point at a distance to a flank—

(*a*) When the distance is so short that the displacement correction can be estimated or measured. In this case the battery commander lays his director set at zero on the target, and then measures the angle to the battery director, noting if the reading is right or left. To this he adds the angle necessary to correct for displacement of the battery director and subtracts the sum so found from 180°. He reverses the direction right or left which was read on his director, and sends the result to the section commander, who sets this angle on the battery director and lays on the battery commander's director. The battery director, if set at zero, would then be laid in the direction of the target.

(*b*) When the distance is too great to estimate the displacement :—

The section commander will set up the battery director in or near the battery position, where the battery commander's director is visible, and will put

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out a sub-base at right angles to the line battery commander's director—battery director. He will send the battery commander the length of the sub-base unless it has been arranged beforehand.

The battery commander will lay his director set at zero on the battery director, and he will then note the reading when laid on the sub-base and on the target. During this time the range takers will take the range to the target, the distance between the two directors, *i.e.*, base will be calculated and the plotter will set the field plotter to the base, range and angle (in the order here named), and hold up the field plotter for the battery commander or his assistant to read the battery angle and battery range.

The battery angle will be left or right according to whether the angle read on the battery commander's director when laid on the target is left or right, or whether the target is left or right of the line joining the battery and the observing station. The battery commander will send the battery angle and direction to the section commander, who will set it on the battery director and lay on the battery commander's director. The telescope of the battery director at zero will then be in the direction of the target.

8c. *Methods of giving parallel lines of fire.*

When the section commander has got the battery director set up so that the telescope, if set at zero, would be in the direction of the target, he can give

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parallel lines of fire to the guns of the battery by any one of the following methods :—

i. By means of an aiming point when the battery director is in the battery position :—

He selects an aiming point and lays the director on it, noting the reading and the direction right (or left). This angle as read will be given out as an angle to all guns "Aiming point.....line of fire..... degrees right (or left)."

The angle ordered will be set on the dial sight of each gun, and the gun traversed till the telescope of the sight is laid on the aiming point. The sight should be at zero elevation and deflection when this is being done.

Section commanders are responsible that the correct aiming point is laid upon, and that the sights are set correctly. If the aiming point is in any direction except in prolongation of the line of guns it will be necessary to correct for parallelism as described in Sect. **10.**

ii. By means of an aiming point when the battery director is in prolongation of the line of guns.

The section commander, in this case, will select an aiming point, which is either in prolongation of the line of guns or very distant, and proceed as above.

In either case he will have to correct for the displacement of the battery director, *see* Sect. **11.**

If any other aiming point than the above be chosen the correction for parallelism may become unnecessarily complicated.

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iii. By means of an aiming point when the battery director is to a flank of the battery position but *not* in prolongation of the line of guns.

In this case the only aiming point which can be used is one which is very distant. Correction for displacement will be necessary.

iv. When no suitable aiming point is available and the battery director is set up in a position to the front, rear, or flank of the battery.

In this case the section commander will give the order "Layers," and the guns will be traversed as nearly as possible on to the line of fire, and an aiming post will be held up at the centre of the dial sight of each gun.

The section commander will lay the director on each of these aiming posts in turn commencing with that of No. 1 gun, and will read the angles so measured and the directions right (or left). The supplements of these angles will be given to the individual guns with the direction reversed. Each No. 1 will acknowledge the receipt of this angle for his gun by saluting. The section commander will make a note of these angles and on his return to the battery will see that they have been received correctly.

The dial sight of each gun will be set at the angle ordered and the layer should give directions to traverse the gun till the telescope is laid on the battery director. During this operation the elevation drum and deflection nut of the dial sight should be at zero.

When this is done each gun will be laid on a line parallel to the line battery director—target, and

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the section commander will have to correct for displacement if necessary.

9. *Use of dial sight as a director and to obtain parallel line to any given gun.*

The dial sight of one of the guns may be used in place of the battery director, and the procedure will be the same as regard getting the dial sight of the gun laid in the direction of the target when set at zero. "Parallel lines to No.....gun" can then be ordered, when the layer at the gun named will lay his sight on an aiming point. The angle recorded on the sight will be given as an order "Aiming point.....all guns.....right (or left)."

The section commander responsible for the line will give any correction required to make the lines parallel if the aiming point is neither very distant nor in prolongation of the line of guns.

A battery commander may order "Parallel lines to No.....gun" at any time if he has got one gun of the battery on to its proper line. Such a case might well occur when using "Single gun ranging" (Example III.), or when a large angle of switch has necessitated the change of position of some guns of a battery to avoid danger angles.

In this latter case the first gun would receive the angle of switch and would give parallel lines to the others.

All deflection should be taken off the sight of the gun of which the line is correct before the angle to the aiming point is measured, but the elevation should be left on the sight, and the remaining guns should have the same elevation on their sights when laying on the aiming point. This is to allow for drift.

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The sight, however, should be reset at the deflection ordered for relaying on the auxiliary mark.

10. *Aiming points.*

An aiming point should be :—

i. Well defined.
ii. Easily described.
iii. As far away as possible.

If lines of fire are obtained from an aiming point, it must be remembered that they will not be parallel unless the aiming point is very distant or in prolongation of the line of guns.

If the aiming point is not very distant and in front of the line of guns the point on which the lines of fire will converge will be in the direction of the target, and at about the same range as the range to the aiming point. If the aiming point is in rear of the line of guns the point on which the lines of fire will converge will be to the rear of the battery, and consequently they will diverge in the direction of the target. Hence it is necessary to apply a correction to open out the lines in the former case and close them in the latter. For an aiming point of any given range the correction required becomes greater the further it is from the line of guns, and the greatest correction is necessary when the line to the aiming point is at right angles to the line of guns.

A rough rule for finding the correction necessary to obtain parallelism, when the guns are at about 20 yards interval, is to divide the angle between the line to the aiming point and the line of guns by the number of thousands of yards in the range to the aiming point. The

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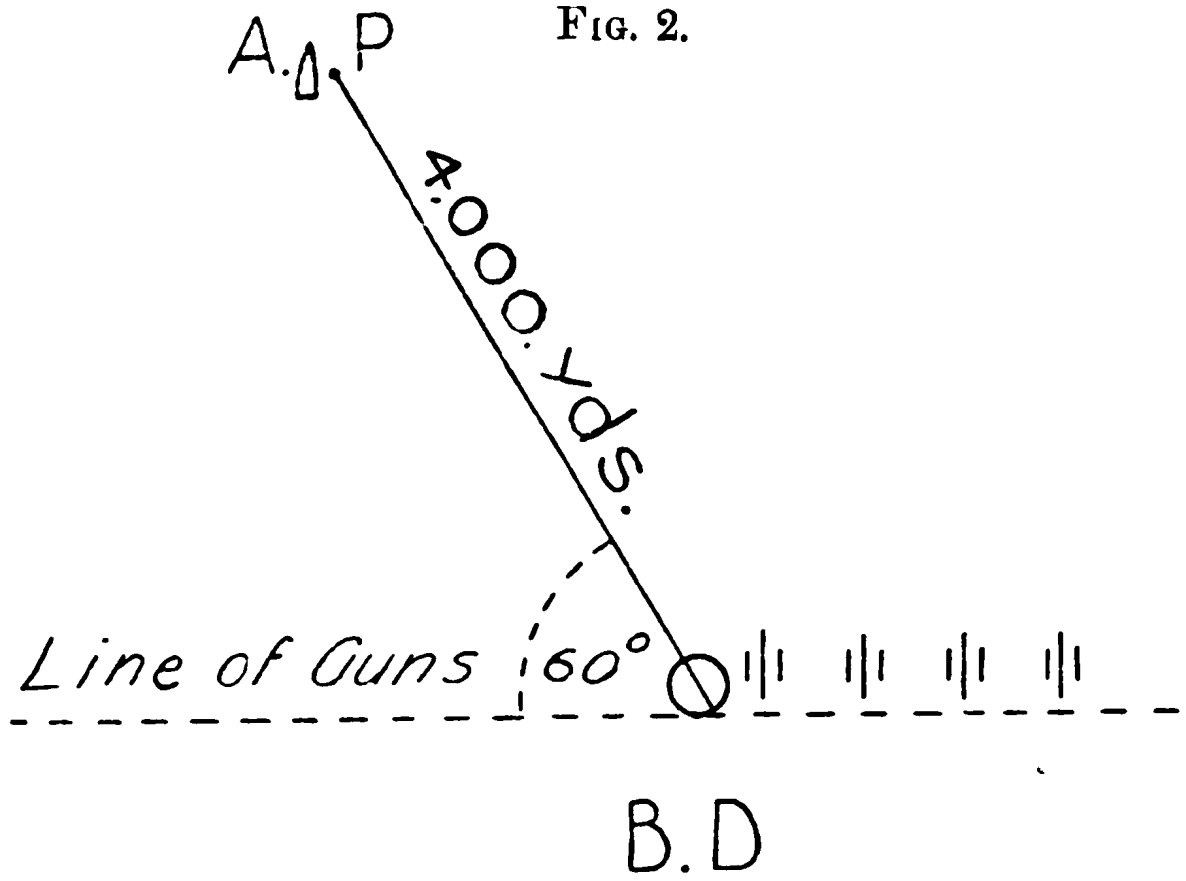
result will give the number of minutes of distribution or concentration required by each gun.

FIG. 2.



This will be given to open out the lines of fire from the gun nearest to the battery director if the aiming point is in front of the line of guns, and to close them if the aiming point is in rear of the line of guns.

For example : in above figure, the correction to obtain parallelism will be calculated as follows :—

$$\frac{60^\circ}{4} = 15'$$

The lines would therefore be corrected as under :—

"Distribute 15 minutes from No. 4."

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11. *Displacement.*

When the centre of the battery is not in the line battery director—target it follows that the parallel lines of fire of the battery will be to the right (or left) of the target.

This is known as displacement, and the section commander must correct for this amount right or left and include the correction in the orders regarding the lines of fire.

Displacement is measured along the line from the centre of the battery or any particular gun perpendicular to the line battery director—target or its prolongation.

This distance should usually be estimated, but if time permits it may be paced.

The correction for displacement may be calculated by the slide rule as explained on page 180, or the following formula may be used :—

$$\frac{6}{10} \times \frac{\text{displacement in yards}}{\text{hundreds of yards in range}} = \text{correction in degrees.}$$

If the director is to the right of the battery, right deflection must be given to correct for displacement and *vice versâ*.

The same principle holds good when an angle is to be sent down from the battery commander's director to the battery director as described in Sec. **8** B, iii.

12. *To obtain the line of fire from an aeroplane or kite.*

This may be done in the following ways :—

i. If the aerial observer can describe the position of the target on a map, the angle to an aiming point can be measured by a protractor, and the line laid out from the aiming point in the usual way.

ii. If the aerial observer can describe the position of the target with reference to some prominent object, this

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object can be used as an aiming point and the line of fire obtained by the usual method.

iii. If the general direction of the target is known, parallel lines in that direction may be obtained by any convenient method. A round will be fired at any convenient range to ensure the fall of the shell being observed, and the line will then be corrected in the ordinary manner according to the observation given by the aerial observer.

13. *To change target.*

To do this it is necessary to ascertain the angle between the old and new targets from some point near the guns.

If both targets are visible from such a point this angle can be measured by means of the director. If they are not so visible the angle can be found by calculating the battery angle for the new target, and taking the difference between it and that for the old target, provided that the battery commander's director and the battery director are in the same position as before.

If the battery commander moves his director to a flank observing station after the line of fire has been laid out, the section commander should note the battery angle to the final position of the battery commander's director, and should send it to the battery commander for use in case of a change of target. In all cases when guns are in action, and even though no target has been indicated, the section commander should set up the battery director clamped at zero in the general direction of the enemy's position, and lay out parallel lines of fire, and auxiliary marks should be picked up and the readings recorded, and should similarly inform the battery commander of the battery angle at the battery director.

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When a target appears the battery commander can then proceed as just described.

Having ascertained the angle between the old and the new targets, the battery commander orders "change target, all guns....more right (or left)" (right if the new target is to the right of the old one and *vice versâ*). This change should be put on the main scale of the sight.

When changing target, if the angle between the old and the new targets is measured from a position which differs considerably in range from the battery, the angle measured must be corrected to battery range by multiplying it by the observer's range and dividing by the battery range.

For this same reason the section commander should inform the battery commander of the position of the battery director as regards the battery, so that, if the battery commander calculates a switch angle by the difference between battery angles to old and new targets, he will be enabled to convert this difference to battery range to arrive at the correct angle of switch for the guns.

14. *Variations required by different equipments.*

The methods of laying out the line of fire in this chapter have been described (for the sake of simplicity) with reference to the 6-inch howitzer provided with a No. 4 dial sight and director No. 2.

The same principles are applicable to any gun or howitzer

Some 6-inch howitzers are provided with gun arcs instead of dial sights.

These gun arcs differ in pattern, some being fitted over the hind sights and some over the fore sights. To avoid mistakes it is desirable to paint "Right" or "Left" on the gun arcs.

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The use of aiming points is somewhat limited with gun arcs, and if an aiming point is used the angle as read by the director should be ordered if the aiming point is in front, but the supplement with direction reversed if the aiming point is in rear.

In all cases when using the No. 1 director it will be set up clamped at zero with the foresight towards the target. In this respect there is no variation from the method of using the No. 2 director. But, if individual angles are being ordered to the guns, the angles as read will be given if the battery director is in rear of the guns, but the supplement with direction reversed if the battery director is in front of the guns.

To avoid complication when using gun arcs the battery director should be placed so that it will not be necessary to give angles to the guns greater than 30°.

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CHAPTER IV.

Battery Drill.

15. *The drill and fire discipline of a battery of four guns or howitzers.*

1. The actual duties of the gun detachments under the section commanders' orders, are given in the handbook of the gun or howitzer. This chapter deals with the drill of the battery as a fire unit, and is equally applicable to a section in cases where the latter becomes the unit of fire.

Whenever a battery or section is in action, all movements of the men will be at the "double."

2. Guns are usually fired without platforms, but when they are likely to be in action in the same place for a considerable time platforms for them should, if possible, be arranged.

3. Heavy howitzers are not adapted for firing without platforms, and are provided with platforms of a special pattern.

Medium howitzers may be employed either with platforms or without. The former is the more normal method with siege artillery when platforms are available and fire has to be maintained for a considerable time from the same position. When, however, platforms are not available, or there is not time to lay them, or an early change of position is probable, the howitzers will be fired from the ground; and this will always be the case when they are employed as mobile batteries. On good ground this presents no diffi-

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culties, but if the ground is soft it will probably be necessary to place planks under the wheels and trail; and the rear ends of these may sometimes with advantage be raised on piles of sandbags, so as to form an inclined plane up which the gun may recoil, and then return to the front.

4. Whether planks are used or not, it is generally advisable to use check ropes made fast to the lowest felloe of each wheel, and to the end of the trail.

When platforms are not employed.

5. When howitzers are employed without platforms, the following will be the procedure.

The interval between guns in action should be not less than 20 yards, except when behind good cover, when the intervals may be somewhat less in order to take advantage of the best ground for individual guns.

6. The battery commander, having selected positions for the guns, and also from which to observe fire, and obtain the line of fire, points them out to the section commanders and observers concerned.

The latter proceed to their stations, and set up their instruments, if such are to be used, and the former bring up the guns.

7. As soon as the first gun of a section has arrived at its position, the section commander will order it to be shifted to the firing position, if not already in that position, if necessary employing both detachments of his section for the purpose.

The remaining gun of the section will be shifted in a similar manner as soon as ready. Each gun is brought into action by order of its No. 1 as soon as it is in the place

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selected for it, and in the firing position, and is loaded by order of the No. 1 as soon as it is ready to be loaded.

8. Guns and howitzers will always be loaded with common or high explosive shell, unless orders to the contrary have been received.

If the battery commander decides to use a different projectile, he will inform the section commanders when pointing out the position for the guns.

9. The line of fire is laid out by one of the methods described in Chapter III, unless "direct laying" is being employed.

10. The ammunition will be brought up on wagons, and the latter will be placed well under cover to the rear and flanks of the battery.

One metal-lined case containing cartridges will be placed about 10 yards in the rear of the centre of each section under cover, and five shell per gun will be placed convenient for use, also under cover whenever such can be found.

This expense ammunition will be kept supplied from the wagons by the ammunition numbers.

When platforms are employed.

11. When the howitzers are mounted on platforms :—

The battery commander will parade the detail at the alarm post, or elsewhere.

The detachments will be formed up in column, right gun detachment leading, and with all details in front, and will be told off. The section commanders will be on the outer flank in the centre of their sections.

The battery commander will order the detachments to be numbered from the front, when each No. 1, in succession from the front, will take a pace to the front, turn to his right, and number off No. 1, No. 2, &c.

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12. Having received reports that all the detail and stores are correct, the battery commander will march off, and on approaching the battery will give the order "March on your guns," when each No. 1 will march his detachment by the shortest way to the left rear of his gun, halting it as much under cover as possible facing the front.

13. The observers and telephonists will march direct to their stations. The section commanders will then give the order to their sections to "Prepare for action."

14. Each No. 1, as soon as his gun is ready for action, will give the command to load, and as soon as it is loaded, will report the fact to the section commander.

The section commanders will report to the battery commander as soon as their guns are loaded.

15. The line of fire will be laid out by one of the methods described in Chapter III.

The subsequent procedure is equally applicable whether the guns are on platforms or not.

With or without platforms.

16. The battery commander's orders will include :—

The method of ranging.
The nature of projectile, if necessary.
The deflection for all guns.
The first elevation or elevations.
The interval, if required.
The order to fire.

These orders should always be given out in the above sequence.

All orders are acknowledged and passed down the battery by the section commanders, who will each give the necessary order to each of their guns.

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17. Guns and howitzers will always be loaded with high explosive shell unless orders to the contrary have been received. Each No. 1 will calculate and give to his gun, if dial sights are not provided, the necessary deflection to correct for difference of level of wheels, and each gun will be laid on its auxiliary mark for line and by clinometer for elevation.

18. When the guns are not on platforms the level of wheels must be taken every round, but when they are on platforms the correction for level of wheels calculated for the first round may be taken as correct for all subsequent rounds at the same target. The level of the platforms will, however, occasionally be checked by the section commanders, in order to see if any further alteration in deflection on account of difference of level of wheels is necessary.

19. As soon as a gun has been fired it will be reloaded by order of the No. 1, and laid as before, unless orders to the contrary are received.

20. Guns should be fired in regular sequence throughout the battery, unless the section commander sees that by maintaining this sequence a considerable delay will occur. Should a gun miss its turn to fire it should not be fired until the turn comes round to it again.

21. The detachment will kneel, sit or lie down whenever the battery commander considers it necessary for them to do so.

22. There are three methods of fire :—

Battery fire.
Section fire.
Gun fire.

In all methods of fire guns are loaded and fired by Nos. 1.

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Battery fire.

23. In battery fire the guns are fired in succession throughout the battery, commencing from the gun whose turn it is to fire next, at the interval ordered.

Section fire.

24. In section fire the guns of each section are fired, at the interval ordered by the battery commander, without reference to other sections.

Gun fire.

25. In gun fire the battery commander orders the number of rounds to be fired, with or without an interval. The specified number of rounds is then fired at the ordered interval. If no interval is ordered, each gun is fired when ready.

Time shrapnel.

26. On the order "Time shrapnel," no more guns will be loaded with percussion shell, and shrapnel will be brought up to the guns with fuzes fixed and ready to be set. On receiving the order as to lengths of fuze, the guns concerned will be at once loaded by order of the Nos. 1, with fuzes set as described in Section 37. On receipt of the order "Fuze... Battery (or Section) fire...seconds" all guns will be loaded with shrapnel with fuzes set at the length ordered, and will continue to be so loaded until orders to the contrary are received, the fuzes being set at the wagon or shell store.

Cease loading.

27. On the order "Cease loading" no gun will be reloaded until orders to do so are given by the battery commander, or until a new target is pointed out, but firing will continue until all the guns are empty. This order is intended for use when only a temporary cessation of fire is required; it is not required in addition to the order "Cease firing."

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Cease firing.

28. Upon this order no more shell will be loaded, but firing will continue until both guns of a section are empty, when the section commander will give the order to the section to "Cease firing," and will order the stores to be collected ready to be replaced.

Stop firing.

29. Upon this order no gun will be fired until the order "Go on," or an order that conveys this meaning, is given.

Change of target.

30. When fire has to be directed on to a new target the guns will be laid on the new target at once, if they are loaded with percussion shell.

31. If they are loaded with time shrapnel, and the range to the new target is the same or less than that to the old one, the guns will be laid at once on the new target. If, however, the range to the new target is greater than that to the old one, the order "Common," "Lyddite," or "Percussion Shrapnel" will be given, the time shrapnel remaining in the guns will be fired at the old target, each gun will at once be loaded with the percussion shell ordered, and the guns will be laid on the new target.

32. It is left to the discretion of the battery commander, when changing target, whether the information obtained when firing at the old target is sufficient to justify his only firing two or more verifying rounds at the new target before proceeding to section or battery fire.

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16. *Management of deflection.*

1. The section commander will repeat each deflection correction ordered by the battery commander, and will at once apply it to any deflection previously given to the gun or guns in question (irrespective of any correction for difference of level of wheels, which is applied independently by the No. 1). For the first round this will be the same as the deflection given by the battery commander. He will call out the resulting absolute deflection to the layer, who will repeat it and put it on his sight. He will enter in his notebook the deflections ordered by the battery commander and the absolute deflections ordered to the layer. Except when the calculations require him to do otherwise, the giving out of the order should precede the entry in the notebook, the latter being used chiefly for record purposes. This record should be kept somewhat as follows :—

No. 2 Gun.

Number of round.	Deflection ordered by battery commander.	Absolute deflection given to layer.	Elevation.
	(Initial deflection) 20′ R.	20′ R.	19°–20′.
2	30′ more R.	50′ R.	20°–40′.
6	10′ more L.	40′ R.	22°.
10	—	40′ R.	21°–40′.

2. The correction for difference of level of wheels will be given by the No. 1. He will take the difference of level to the nearest $\frac{1}{4}$ degree as soon as the gun is approximately in the line of fire, calculate to the nearest five minutes the

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deflection necessary to correct for it, and call out to the layer ".....more R. (or L.)."

3. The layer will put this deflection on his sight, as ordered. The deflection given by the section commander must always be put on the sight before the deflection for difference of level of wheels.

17. *Duties of the battery commander.*

1. He is responsible that the battery detail is complete, both in men and stores.

2. When platforms are to be employed, he will select the positions for them, and also positions for observing stations, in accordance with instructions received from the brigade commander.

3. He will make arrangements for pointing out targets to the observers, and for the establishment of telephonic communication between the observers and the battery, and should endeavour to obtain from the observers, and note down, as much information (as to targets, &c.) as possible, while the platforms are being laid.

4. When platforms are not employed, he should always precede his command to select a position for the guns, or to make himself acquainted with it if it has already been selected for him, leaving the next senior officer in charge to bring on the guns.

On arrival at the position, he will select the exact position for each gun, determine what method of observation to employ, and select the observing stations for himself and the observers.

5. He will ascertain the range to the target allotted

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to him, and give instructions as to the laying out of the line of fire.

As soon as the range has been ascertained, he will determine the elevation and deflection, allowing for angle of sight, drift, if required, displacement, and wind. He will direct his assistant to note these on the ranging sheet, and will call them out, or signal them, to the section commanders.

6. He is responsible that the ranging is carried out in accordance with one of the methods described in Chapter VI.

7. It being indispensable to economize ammunition, a round should never be thrown away by hastily firing a second shot when the first has gone wide of its mark, but the necessary corrections should be first carefully looked up, considered, and applied. In the case of an obvious error, an attempt should be made to trace the cause of the error.

8. Information with regard to the enemy which the battery commander may obtain, either by his own observation or that of his observers, should always be forwarded to the brigade commander.

18. *The battery commander's personnel.*

1. The battery commander requires a personnel of three men. These are called the "battery commander's assistant," "No. 2" and the "plotter" respectively.

2. The battery commander's assistant is a non-commissioned officer selected from among the trained observers. He will keep the battery ranging sheet, and with "No. 2" assist the battery commander in any other way that the latter may direct.

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3. The special duty of "No. 2" is to assist with the director.

4. The plotter is a non-commissioned officer or gunner trained as an observer. He will receive all the information sent in from the observers, manipulate the field plotter if used, combine the observations of the observers, and give the results to the battery commander, and perform such calculations as the latter may direct.

5. When available, an officer will be employed on the battery commander's personnel as an observation officer.

19. *Duties of the section commander.*

1. Section commanders are responsible for the efficiency of their sections in every particular. They will see that the men and stores for their sections are correct, and report accordingly to the battery commander.

2. All orders received from the battery commander must be acknowledged by a salute, and passed on, word for word, before being given as an order to the section or gun concerned. The nearer section commander is responsible that all orders are correctly received and repeated by the other section commander.

If the battery commander considers the conditions tend to facility in hearing the orders, he may direct that the orders be merely acknowledged without repeating back.

3. If, in giving an order, the battery commander makes an obvious verbal slip, it is the duty of the section commander nearest to him to draw his attention to it.

4. All orders to a section must be prefaced by the name of the section.

5. Whenever the section commander is temporarily absent the senior No. 1 of the section will act for him.

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6. A gun is never to be fired except by his order.

7. Each section commander is responsible that his guns are not fired when within the danger angle. If the guns cannot be run up or back so as to comply with this (as when platforms are employed), he must withdraw the detachment from the gun adjacent when the other gun is fired.

(The "danger angle" is 45° between the line of fire of a gun and a line from its muzzle to the muzzle of the next gun. If this angle is less than 45°, the gun is said to be within the danger angle.)

8. Each section commander is responsible that the trajectory of his guns will clear the ground in his immediate front.

To ascertain whether the trajectory will clear the ground in front, lay the gun by clinometer at the elevation due to the range; then set the tangent scale to a liberal estimate of the distance between the crest of the ground and the gun, and see whether the line of sight will clear the ground in front.

9. When a gun is out of action, or a casualty happens to any part of the equipment, the section commander should ascertain if it is possible to rectify it with the means at his disposal before reporting it.

10. The section commanders should occasionally, at their discretion, check the laying and level of the wheels.

11. The section commanders will call out the absolute deflection for their guns each round, whether any correction has been ordered by the battery commander or not. (*See* Sec. 16.)

12. Should the battery commander consider it necessary to apply any correction in elevation found from previous shooting to be required by any individual gun, the section commander, in whose section the gun is, will apply this

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correction to the elevation ordered by the battery commander before the elevation is given to the gun concerned.

20. *Duties of observation officer.*

1. The observation officer is responsible for the efficiency of the observing parties in all respects.

2. He will accompany the battery commander when the position for the observers and battery are being selected.

3. He will superintend the taking up of positions by the observers, the arrangements for communication, and selection of reference points, if required.

4. He will in action supervise the work of the observers generally.

5. He will perform such other duties as the battery commander may direct.

21. *General causes of bad shooting.*

The following are the general causes of bad shooting :—

1. Incorrectly weighed charges. Small differences in the weight of cartridges considerably alter velocities.

Difference in temperature of cordite cartridges.

2. Using different lots of cordite, a service condition that will constantly occur; cartridges containing the same lot should be segregated. When a change of lot of cordite cannot be helped, the battery commander should be informed, and a fresh ranging group should be begun, the results being corrected for in the ordinary way.

3. The shell slipping back into the chamber after elevating, due to inadequate ramming. This is a very frequent cause of bad shooting with the 6-inch B.L. howitzer.

4. Not ramming successive rounds home to exactly the

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same point. This is most important, very slight longitudinal differences along the rammer-stave of a comparatively large calibred piece quite alter the air spacing of the charges; variation in the ranges obtained being the result.

5. An unsteady or carelessly-adjusted trail plank; badly laid platforms.

6. Not running the gun up to the same place; this is specially the case when the laying back mark is a near one.

7. Faulty manipulation of the sights; the layer should be careful that the clamping of the sights has not shifted from previous firing.

8. Not putting the clinometer in the same place on the clinometer plain; grit or dirt being between it and the gun; not bringing the bubble to the same place for successive rounds. It has been found that more regular results are obtained by bringing the bubble tangential to a line on the glass.

A gun laid before the firing of the one next it, should, after the firing of the latter, have its laying checked.

9. Not properly adjusting the friction cone or plates of the elevating gear, or the friction cone or plates working loose during firing, or oil working into the friction plates or cone.

10. Making the last turn of the elevating wheel one of elevation instead of depression, and omitting to give sufficient depression to take up backlash.

11. Laying on different parts of the auxiliary mark.

12. Want of method in tabulating results and in calculating corrections, constant change of elevation, or departing from the bracketing system of ranging without good and sufficient reason, and failure to take into consideration the angle of sight.

13. Faulty observation of fire.

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22. *Signals that may be used.*

Nature.	By whom given.	Meaning.
Motions with the hand in required direction.	No. 1 or layer ...	Elevate, depress, trail right or left.
Drops his hand	No. 1 or layer ...	Halt, elevating or traversing.
Runs to trail...	No. 1	Run up.
Slides his handspike to the rear	No. 1	Halt running up.
Whistle	Battery Commander.	Stop firing (to be followed by "Go on").

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CHAPTER V.

Observation of Fire.

23. *General instructions.*

1. Observation of fire may be carried out in various ways, according to the instruments and time available.

On the care and skill of observers the success of siege practice largely depends, and no effort should be spared to ensure that the results of observation of fire are accurate and reliable.

2. Observers should be practised regularly in picking up and clamping their instruments on natural targets, in accordance with instructions signalled or telephoned to them from a position representing that of the battery; in rapidly noticing and reporting the appearance of fresh objectives; in describing their position and nature intelligently, and in making rough sketches of them. Valuable practice in observation can also be obtained by the use of cordite puffs to represent the flash of hostile guns and powder puffs the burst of shell fired from the battery, for which the observation is being carried out.

3. The different methods which can be employed may be conveniently divided into four groups; but it must be clearly understood that this division is merely for convenience of description, and is not intended to preclude a combination of methods being employed when, as will, in fact, often be the case, this appears advisable.

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Observation of fire, then, will be considered under the following headings:—

(*a*) When observation is carried out by one observer only, who is usually the battery commander.

(*b*) When a second observer is employed, but observation of fire instruments are not available.

(*c*) When two observers are employed, each of them being provided with a telescope fitted with graticules and mounted on a rigid support, such as the observation of fire instrument.

(*d*) When an observer in a balloon or aeroplane is employed, either alone or in addition to any of the above.

Observation carried out under (*a*) and (*b*) will be known as "visual" observation, observation under (*c*) as "instrumental" observation, and observation under (*d*) as "aerial" observation.

4. Instrumental observation is only accurate when both observers have their instruments directed on to exactly the some point in the target; otherwise, it is not only inaccurate but most misleading. Consequently it may be said at once that, if it cannot be ensured that both observers are observing with reference to the same point, instrumental observation should not be employed.

Apart from this very definite consideration, the choice of which form of observation to use will depend upon a variety of circumstances: chiefly upon the nature of target and of light, the facilities which exist for obtaining good positions for observers and establishing communication with them, and the time available for the observers to get in position.

For instance, a target with no definite point on which to clamp observers would necessitate visual observation under (*a*), while for firing at a gun only located by its flash instru-

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mental observation would be employed if possible, or visual observation under (*b*); night firing can as a general rule only be carried out by instrumental observation.

24. *When observation is carried out by one observer only.*

1. The essential feature of this system is that, unless the observation is carried out under exceptionally favourable conditions, no attempt must be made to estimate the distance of the fall of a projectile over or short of the target. The observation must be made simply as over or short (+ or −), and when there is the slightest doubt as to whether the shell fell over or short, the round should be recorded as doubtful (?), and repeated.

2. Observation with the naked eye is, generally speaking, inaccurate and not to be relied on; glasses should, therefore, be used.

3. Observation, as a rule, depends upon the power of noting whether the smoke of a bursting shell is beyond or short of the target; and this is usually only possible when the shell falls laterally within the limits of the target or (when there is a cross wind) slightly to the windward side of it. The observation of shell which fall considerably wide of the target is, therefore, generally unreliable; and this is especially the case when the wind is blowing more or less directly to or from the target.

It is almost invariably necessary to correct for line only, until a reliable observation as regards range is obtained.

4. Difficulties of observation often arise from light and background which render the target almost invisible and very difficult to pick up again, once the eye is taken off it; in such cases assistance may be obtained by aligning two

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pieces of stick on the target, as a guide to direction, at any rate.

5. A target may be on marshy ground, when the bursting shell will be smothered; or close in rear of a depression, when a shell that falls short may drop into the hollow and its smoke (becoming thinner as it rises) allows the target to be seen through it, so that the shell appears to have burst beyond the target.

6. If the target is in front of a depression, shells falling over may not be observed at all. In such cases, however, negative information may often be obtained—as, for instance, if the ground short of the target is clearly visible, but not that beyond it, an unobserved shell is probably over; and, conversely, if the view short of the target is obstructed, but not that beyond it, an unobserved shell is probably short.

7. More definite observations, however, can be obtained as to the fall of shell as regards line, the accuracy of the estimate depending upon the means of observation employed and the experience of the observer, but an attempt should always be made to estimate the amount (in minutes or degrees) that a shell falls right or left of the target. The best means of doing so is to have graticules fitted to the telescope or field-glasses used or, failing this, to know the field of the glass and practise estimating fractions of it. Various other expedients may be made use of, derived from the fact that the tangent of an angle of one degree is approximately 1 over 60 (accurately, 1 over 57·3). Thus, for instance, if an ordinary foot rule is held out at arm's length, each half-inch will roughly represent one degree; or a more accurate arrangement may be made by dividing the distance between one's eye and outstretched hand by 57·3, and marking off on a strip of wood intervals of the length so found.

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8. Whenever any of these rough aids is employed, the best way to make use of it is to fix in one's mind the width of the target in minutes before commencing fire, and then estimate the fall of the shell by comparison.

25. *When a second observer is employed, but not observation of fire instruments.*

1. The battery commander should always observe fire himself, provided it is possible for him to do so without prejudice to his efficient command of his battery. The use of signalling or field telephone for passing his orders to the battery will admit of his being some distance from it.

But great assistance may be obtained from an observer sent out to a flank, whose observations may corroborate those of the battery commander in case of doubt, or may supply their place when, for any reason, the battery commander has been unable to observe a round. Or the flank observer's observations may be combined with those of the battery commander, according to the method described below; and this form of observation is necessary when the target (such as a disappearing gun or a gun only located by its flash), is only visible at intervals.

2. In the following description of this form of observation for two observers, the battery commander himself may or may not be one of them. If he is, signalling communication must be established between him and the other observer, and if his position is not close to the battery, also between him and the battery. If the battery commander is not himself one of the two observers, signalling communications must be established between him and each of them.

3. One of the observers should always be placed as near the line of fire as possible, and the other some distance off

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on a flank. Their positions should be selected so as to give a good view, but (subject to this) should be as much under cover as possible. All signalling should be done under cover from the front.

4. Each observer should be provided with a telescope or field glasses, and if the target is indistinct or only visible at intervals, its direction must be marked in some way.

5. The fall of a shell is recorded by each observer as either in line with, or right or left of, his line of observation to the target; but when a round is seen to be clearly over or short it should in addition be so reported.

The results of each round are signalled by the semaphore or morse code, and are combined by the battery commander in the way that will now be described. It will be noted that it is essential for the success of this method that both the observers should be observing with reference to *the same point* in the target; otherwise the results will be misleading.

6. It is of first importance to understand the principle of this form of observing.

This is best done by means of Fig. 3, in which G. is the gun, R.O. the right observer, L.O. the left observer, R.O. r.o. is the right observer's line of vision through the target, and L.O. l.o. is the left observer's. G. g. is the line of fire from the gun. All these lines intersect at the target.

Now any shell which falls in the shaded portion, marked S, will be reported "right" by the left observer, and "left" by the right observer; and it must certainly be "short,' but may or may not be "line."

Any shell which falls in the shaded portion, marked Y, will be reported "left" by the left observer and "right" by the right observer; and it must certainly be "over," but may or may not be "line."

Similarly, any shell which falls in the shaded portion,

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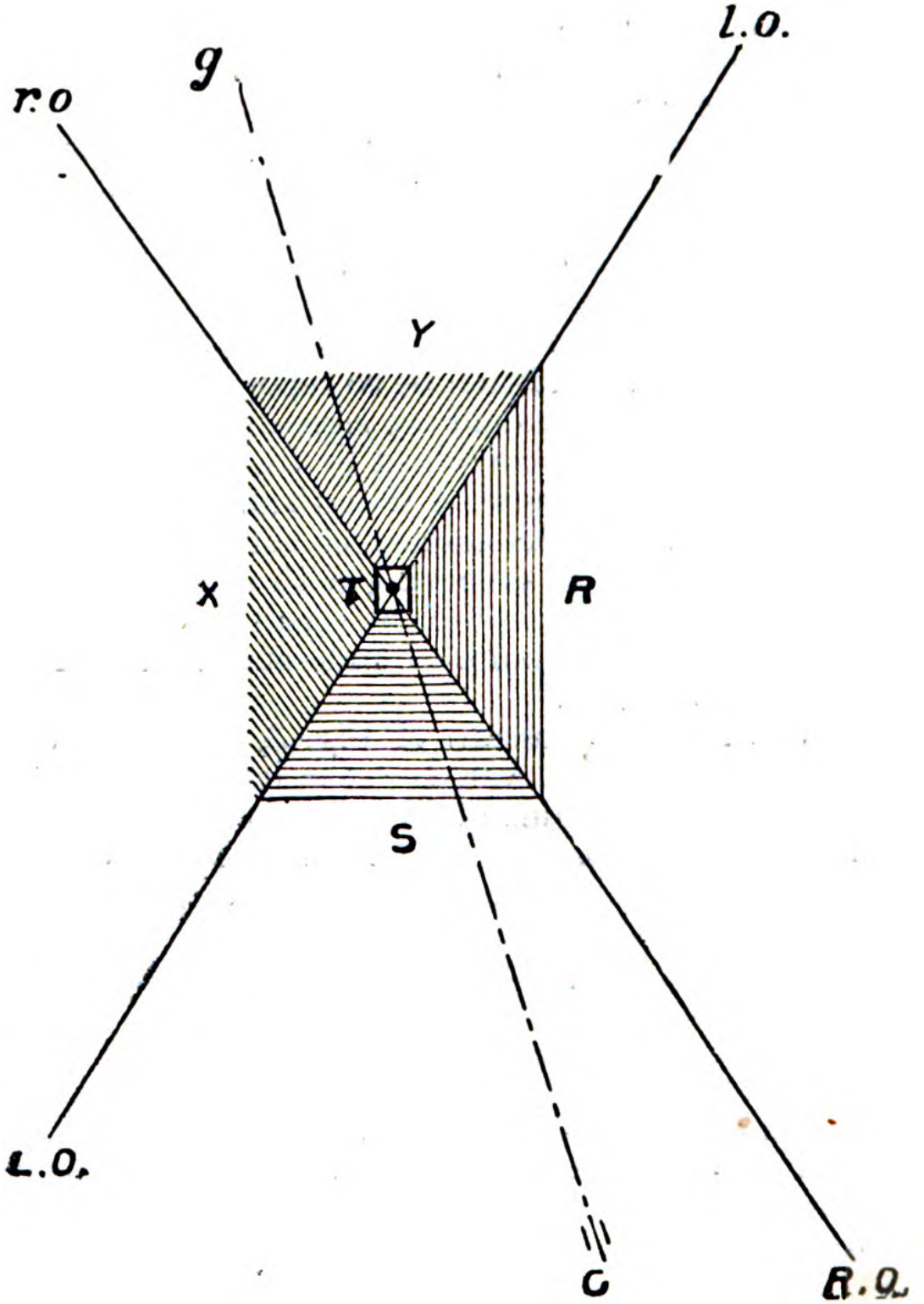
FIG. 3.



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marked R, will be reported "right" by both observers ; and it must certainly be "right," but may be either "over" or "short."

And any shell which falls in the shaded portion, marked X, will be reported "left" by both observers ; and it must certainly be "left," but may be either "over" or "short."

Also, any shell which falls on the line L.O.—T., will be reported "line" by the left observer and "left" by the right observer ; and it must be "short" *and* "left," and so on.

7. From the above it is clear that if both observers report a round as being "right" or "left," reliable information is obtained as regards line, but none as to range.

If, on the other hand, one observer reports a round as being "right," and the other reports it as being "left," reliable information is obtained as to "range" but none as to "line."

It is only when either observer reports a round as being "line" that reliable information is obtained as to both "line" and "range."

8. The deduction arrived at from each round and the form of correction which is indicated therefrom will accordingly be as in the following example.

Round.	L.O.	R.O.	Conclusion at battery.	Form of Correction indicated.
1	Left	Left	Left...	Alter deflection.
2	Left	Right	Over	Alter elevation.
3	Right	Right	Right	Alter deflection.
4	Right	Left	Short	Alter elevation.
5	Left	Right	Over	Alter elevation.
6	Line	Left	Left and short ...	Alter deflection and elevation.
7	Left	Right	Over	Alter elevation.
8	Left	Line	Left and over ...	Alter deflection and elevation.
9	Line	Line	Line and range ...	No alteration.

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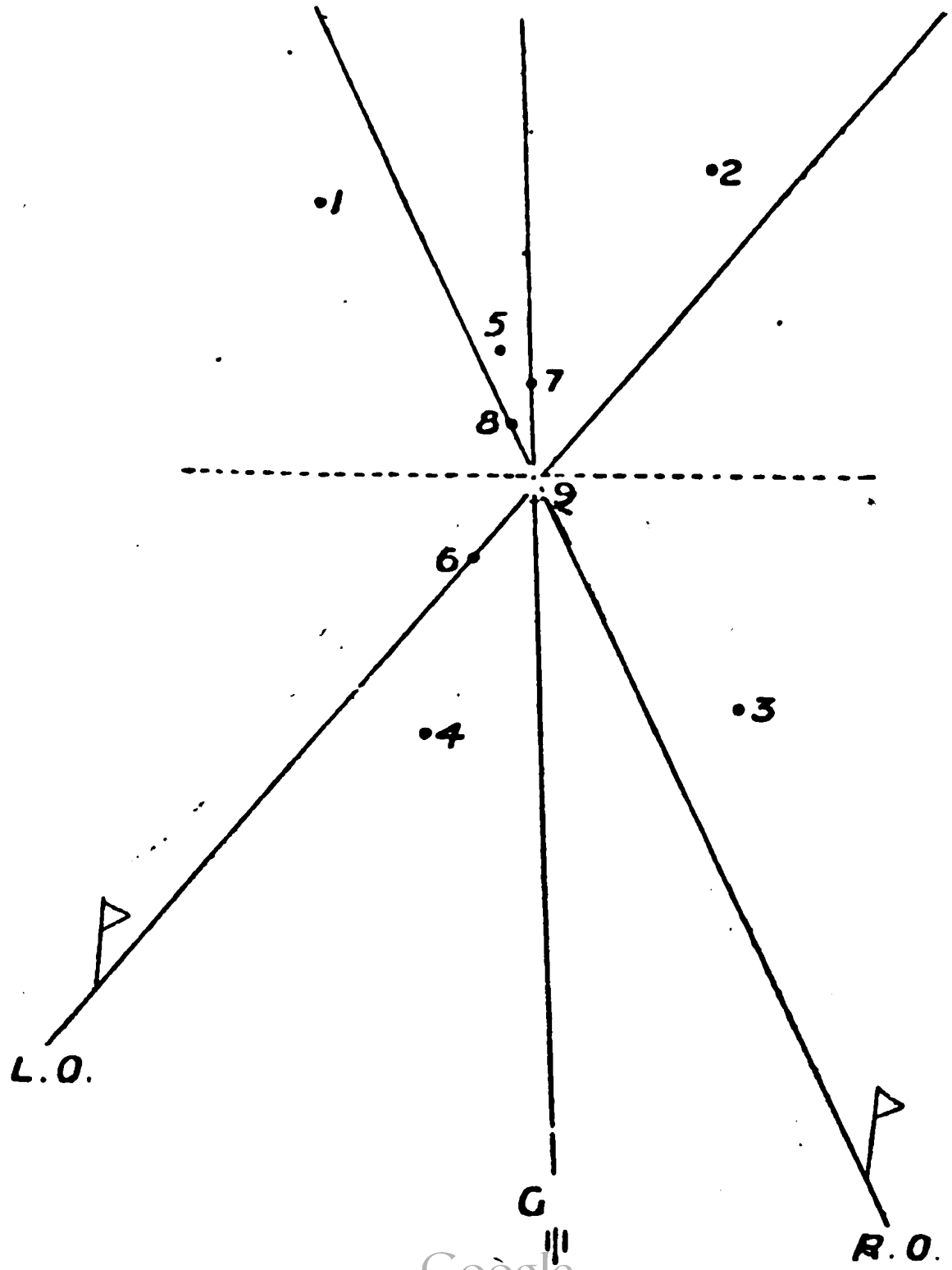
The position of each round is shown in Fig. 4. It will usually be found of great assistance to make a rough figure of this sort when ranging by this method :—

FIG. 4.



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9. The above is an example of the simplest form of this method of observation of fire by means of two observers.

More definite results may be obtained if the observers can estimate, even roughly, the *amount* right or left that each shell falls. This may be done, at any rate to within a quarter of a degree, by various simple means.

For instance, if the two pieces of stick, previously mentioned as being placed in line with the target, are placed about 19 yards apart, half degrees can be marked by placing smaller pieces of stick in the ground right and left of the further one at intervals of 6 inches. The observer then places himself at the nearer of the two sticks previously referred to, and has a rough means of estimating amounts to quarter degrees.

10. A more satisfactory way is to use a telescope or field glass whose field is known ; for instance, if the centre of the field of a telescope having a field of one degree is directed on to the target, it is easy to estimate the amounts right or left to the nearest quarter degree. Similarly with other telescopes or field glasses.

11. The field of all glasses used should be known, or if it is not it should be measured. This can be done either by looking through the glass and noting any two objects which come at the extreme edges of the field, and then measuring the angle between them by any angle measuring instrument such as a sextant or an observation of fire instrument ; or by standing opposite a wall, at a distance of 19 yards from it, looking through the glass, and causing a mark to be made on the wall at each edge of the field ; the distance apart of these two marks in feet will give the field of the glass in degrees, and each inch will therefore equal five minutes.

12. Whatever means is employed for forming a rough estimate of the amount right or left of the fall of a shell, the advantage gained by it is that a round which is reported

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"right" or "left" from both observers can be placed as regards range as well as line ; and a round which is reported "right" from one observer and "left" from the other can be placed as regards line as well as regards range. And, provided one observer is not far from the line of fire, the result as to "line" gives the approximate amount of the error, which can therefore be corrected without the necessity of bracketing.

13. The principle is exactly the same as in the last case, but the information as to the *amount* a shell falls right or left of each observer's line to the target, enables a little more information to be obtained as to the fall of the shell. To do this it is necessary to remember (a figure is an assistance in doing so) that a shell which is reported "right" from the right observer or "left" from the left observer has a "tendency" to be "over," and a shell which is "left" from the right observer or "right" from the left observer has a "tendency" to be "short."

Consequently it is only necessary to take the *greater* of these "tendencies" in order to arrive at a more definite conclusion as to the fall of any shell.

14. An example will show what is meant. Taking the same figure and rounds as before :—

Round 1 would be reported by the left observer as $\frac{3}{4}°$ L., which has a "tendency" to be "over." It is reported by the right observer as $\frac{1}{4}°$ L., which has a "tendency" to be "short." Combining the two observations, it is seen at once that the "tendency" to be "over" is greater than the "tendency" to be "short," and therefore it was known that the shell was "over" as well as "left."

This information was not possible under the previous conditions. The elevation can be reduced as well as the deflection altered, and thus a round is saved.

By plotting in each round very roughly to scale by eye,

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the relative position of each shell to the target can usually be seen at once.

Taking the remaining rounds in the same way, and comparing them with the previous example, each round independently, and not collectively as a series, they work out as follows (the right observer is supposed to be fairly close to the line of fire):—

Round.	L.O.	R.O.	Conclusion at battery.	Form of Correction indicated.
	(deg.)	(deg.)	(deg.)	
1	¾ L.	¼ L.	¼ L. and +.	Alter deflection and elevation.
2	¼ L.	½ R.	½ R. and +.	Alter deflection and elevation.
3	½ R.	¼ R.	¼ R. and —.	Alter deflection and elevation.
4	¼ R.	¼ L.	¼ L. and —.	Alter deflection and elevation.
5	¼ L.	¼ R.	¼ R. and +.	Alter deflection and elevation.
6	Line	¼ L.	¼ L. and —.	Alter deflection and elevation.
7	¼ L.	Line	Line and +.	Alter elevation.
8	¼ L.	Line	Line and +.	Alter elevation.
9	Line	Line	Line and range.	No alteration.

26. *When two observers are employed, each of them being provided with a telescope fitted with graticules and mounted on a rigid support, such as the observation of fire instrument.*

1. Under these circumstances, still more definite information can be obtained, on account of the greater accuracy of the observation made possible by the graticules.

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Supposing graticulated telescopes to be available the preceding example might be observed as follows :—

Round.	L.O.	R.O.	Conclusion at battery.	Form of Correction indicated.
	(min.)	(min.)	(min.)	
1	40 L.	5 L.	5 L. and +.	Alter deflection and elevation.
2	12 L.	28 R.	28 R. and +.	Alter deflection and elevation.
3	20 R.	5 R.	5 R. and —.	Alter deflection and elevation.
4	6 R.	15 L.	15 L. and —.	Alter deflection and elevation.
5	15 L.	3 R.	3 R. and +.	Alter elevation.
6	Line	7 L.	7 L. and —.	Alter deflection and elevation.
7	7 L.	4 R.	4 R. and +.	Alter elevation.
8	10 L.	Line	Line and +.	Alter elevation.
9	Line	Line	Line and range.	No alterations.

2. This is a step further than the last case. There is also the advantage that greater confidence can be placed in the results of the observation, and the deflection can be corrected with greater accuracy. It is possible whenever any form of telescope fitted with graticules is available for the observers. By taking full advantage of the "tendencies" referred to above, several rounds can be saved.

3. But when observation of fire instruments are available, they provide a means of finding the ranges to the target from the battery and from each observer, and also the "apex angle" (as described later); in that case more information still can be obtained. An estimate can, in fact, be formed of the *distance* over or short that each round has fallen.

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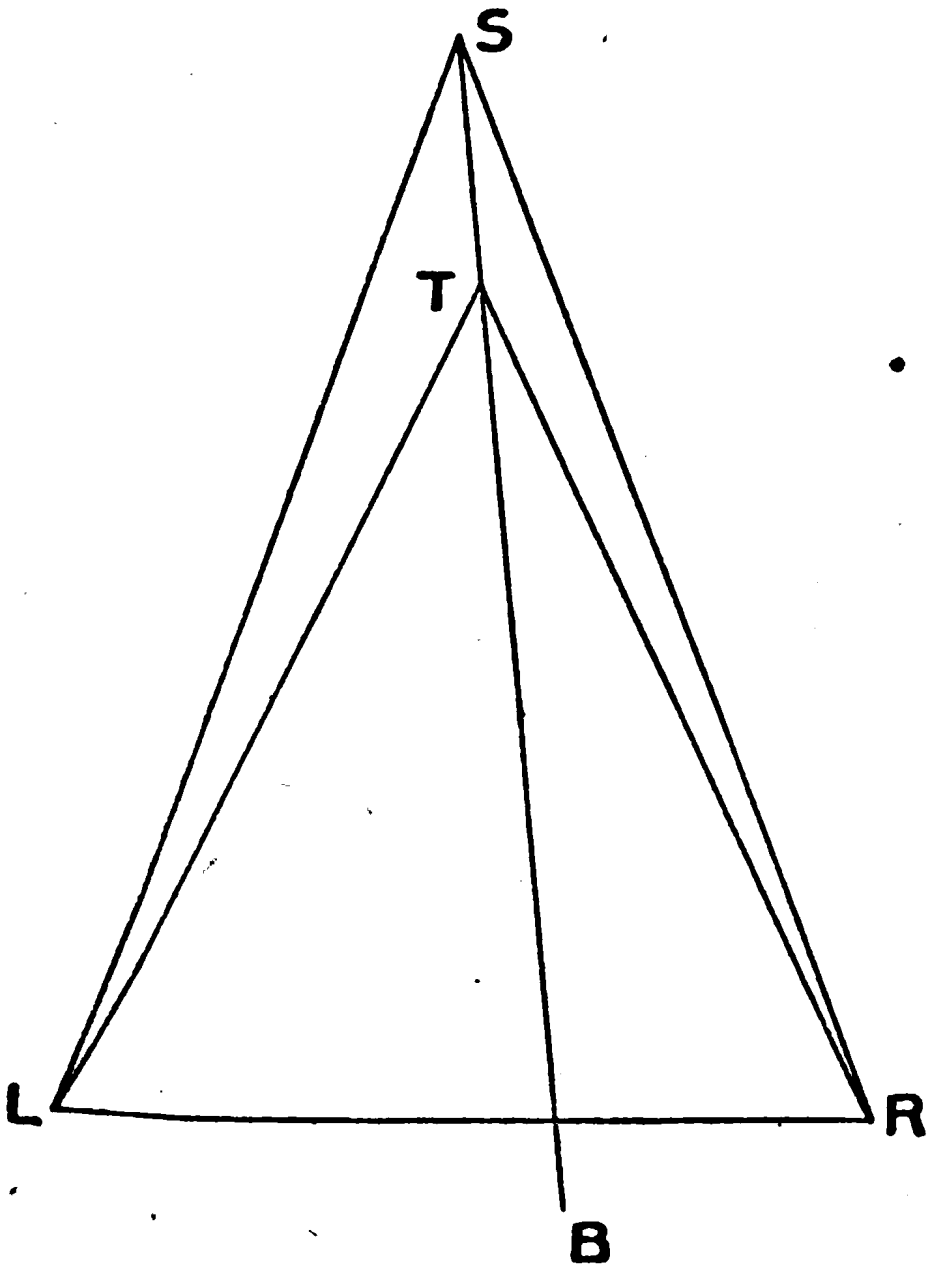
4. The principle upon which the estimate of the *amount* over or short is based is as follows :—

In Fig. 5, B is the battery, L and R the observers, T the target, and S the position of the burst of a shell.

Now, as long as the positions of L and R are fixed, and at

FIG. 5.



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approximately equal distances from T, these distances vary inversely as the apex angle L T R, for various positions of T. That is to say, the shell-burst, S, may be taken for a new position for T, and then the distance R S will bear the same proportion to the distance R T that the angle L T R will to the angle L S R; or, in other words, if a shell falls at S, its distance beyond the target will bear the same proportion to the consequent decrease in apex angle that the original range did to the original apex angle.*

5. Now, if the observers at L and R are provided with telescopes fitted with graticules, they can each observe the number of minutes left and right respectively of the target of the fall of the shell at S. And these minutes may be regarded as an increase of the base angles T L R and T R L respectively, and a consequent decrease of the apex angle by their combined amount, resulting in a corresponding increase of range.

---

* Let R = Range.
„ r = Increase of range.
„ A = Apex Angle.
„ a = Decrease of Apex Angle.

Since the range varies inversely as the Apex Angle.

$$\frac{R + r}{R} = \frac{A}{A - a}$$

then $$\frac{R + r}{R} - 1 = \frac{A}{A - a} - 1$$

$$\therefore \frac{R + r - R}{R} = \frac{A - A + a}{A - a}$$

$$\therefore \frac{r}{R} = \frac{a}{A - a} \text{ or } \frac{R}{r} = \frac{A - a}{a}$$

But a is very small compared with A

$$\therefore \frac{R}{A} = \frac{r}{a}.$$

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6. In this particular case each observer's observation tends to increase the base angles, and, therefore, decrease the apex angle, and, consequently, increase the range, so that the total alteration in the apex angle is the *sum* of the two observations. The *sum* of the observations would also be taken if both tended to decrease the base angles. If, however, both observations are "right" or both "left," one tends to increase the base angles and the other to decrease them, so that the net increase or decrease of apex angle is the *difference* between the two observations.

7. In practice it is convenient to write down a + in front of an observation "right" from the right observer, and in front of an observation "left" from the left observer, as these would each tend to increase the base angles, decrease the apex angle, and increase the range, and, similarly, to write down a − in front of observations "left" from the right observer and "right" from the left observer, as these would each have a tendency to be short. The algebraical sum of the two observations is then taken, and this gives the amount the shot has fallen over or short, measured in "minutes of apex angle."

8. Taking the previous example again, the result of each round in "minutes of apex angle" would be as follows :—

Round.	L.O.	R.O.	Result in minutes of apex angle.
1	+40	− 5	+35
2	+12	+28	+40
3	−20	+ 5	−15
4	− 6	−15	−21
5	+15	+ 3	+18
6	± 0	− 7	− 7
7	+ 7	+ 4	+11
8	+10	± 0	+10
9	± 0	± 0	Range.

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9. Now using the proportion $\frac{\text{range}}{\text{apex angle}}$ as a factor or constant, it becomes a simple matter to convert the "minutes of apex angle" into yards, provided the apex angle and range are known; and the method of finding these is explained later (pages 72 and 74).

10. Continuing the above example, and supposing the range to be 3,000 yards and the apex angle 10° *i.e.* 600′, the proportion $\frac{\text{range}}{\text{apex angle}}$ becomes $\frac{3{,}000}{600} = \frac{5}{1}$. That is to say, every "minute of apex angle" is equivalent to 5 yards of range, and it is only necessary to multiply each result in the last column by 5 to obtain the fall of each round in yards.

The results will then be "+ 175 yards,' "+ 200 yards," &c.

11. When the proportion $\frac{\text{range}}{\text{apex angle}}$ does not work out to a whole number, it is convenient to use a slide rule. The rule should be set with the "minutes in the apex angle," on the slide, under the "range in yards," on the rule; over each result in "minutes of apex angle" will then be found the equivalent result in yards.

12. Up to the present it has been supposed that the observers are equally distant from the target. If they are not, the results of one of them must be corrected so as to be the same as if they were, and, in practice, it is convenient to correct the results of both to what they would have been if both observers were at the same distance from the target that the battery is.

13. The method of doing so is simple. In Fig. 6 the right observer is at R, closer to the target than the battery is.

If he were at R′, the same distance from the target as the

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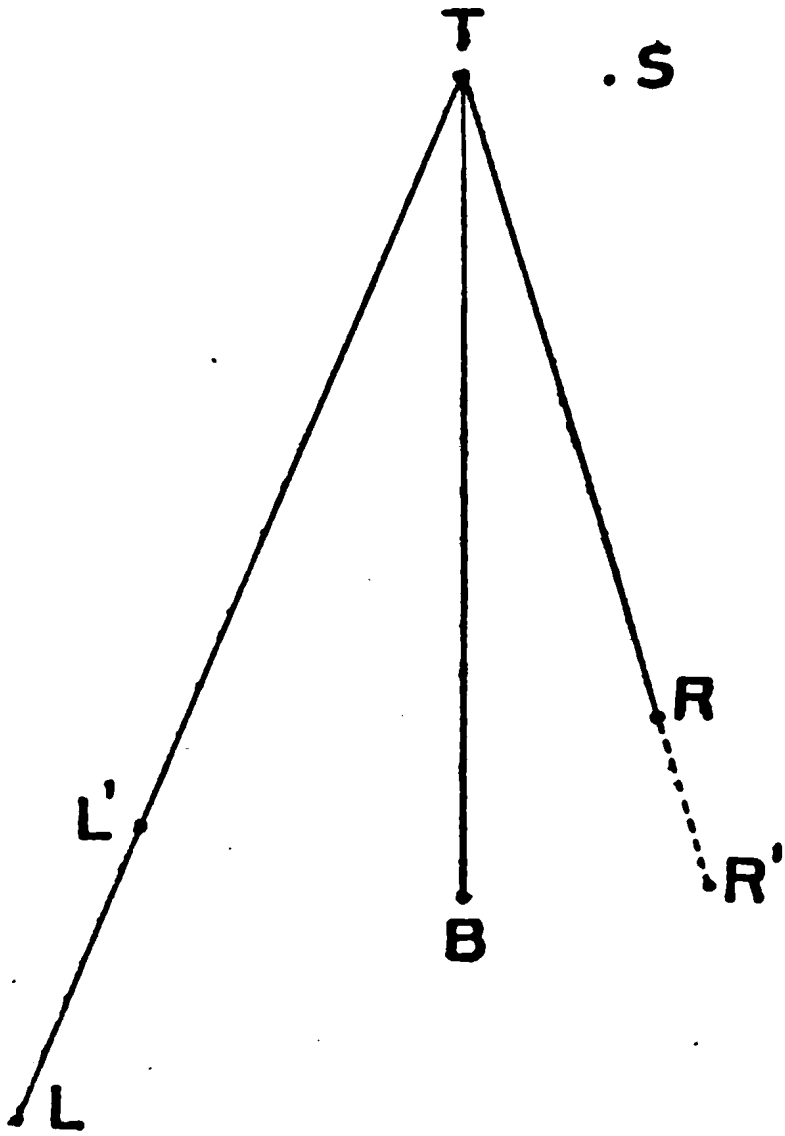
FIG. 6.



battery is, the number of minutes to the right that he would observe a shell bursting at S would be less than the number actually observed at R (as the angle subtended is smaller), and the amount less would be just so much as R T is less than R′ T, that is, in the proportion of R T to B T.

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Similarly, if the left observer were at L′ instead of at L, as he is, his observations of a shell bursting at S would be larger than they actually are in the proportion of L T to L′ T, that is, in the proportion of L T to B T.

14. With the aid of two slide rules, the correction of each observer's observations to what it would have been if observed at the same range as the battery, is made as follows :—

A separate slide rule is used for each observer, and they should be marked R.O. and L.O. accordingly. Each slide rule is set by placing the battery range on the slide, under the observer's range, on the rule. Then when an observation is sent in by either observer, above the number of minutes on the slide (of the corresponding rule) will be found, on the rule, the equivalent number of minutes at the battery range.

The observers' reports are written down by the plotter on the "record of observation" form, on the left of the + or − sign as explained above, and the results, corrected to battery range, are then written on the right of the same signs.

The algebraical sum of the two corrected readings is then taken and written down in the last column of the form, together with the corrected reading of the observer who is the nearest to the battery.* This latter is for the use of the battery commander in correcting the line, as explained in the chapter on ranging (Chapter VI.).

15. A full description of the "observation of fire instrument" is given in Appendix I, but any telescopes fitted with graticules, and mounted on a rigid tripod, for the purposes of observing only, can be used instead of them.

---

* Unless a line factor is employed, *see* p. 110.

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27. *Method of using the observation of fire instruments by day.*

1. The instruments are carried to the stations in their boxes, being previously carefully examined to see that they are in all respects complete and correct. Each observer on reaching his station will communicate his name and that of his station to the battery. He will note in writing all observations made, and all messages sent or received.

2. Each battery should have its own separate system of observation, for which two instruments are required. Occasionally it may be necessary, when two or more batteries are firing at the same target, to place them under one pair of observers. In this case each of the observers must be in communication with each of the batteries, or with some central post, if such can be arranged, whence their messages can be rapidly conveyed to the batteries.

3. Whenever possible, there should be two observers with each instrument. They should relieve each other frequently, and the one who is not observing with the instrument should observe with field-glasses, and also keep a constant look-out for fresh targets, &c.

4. The instruments are set up as follows :—

(*a*) Set up the tripod, roughly level.

(*b*) Place telescope on tripod, and secure it by the locking plate and clamp the latter.

(*c*)†Fix on the sighting arm, screwing up the fly nuts.

(*d*) Focus graticules of eyepiece until they are clearly seen ; then direct telescope on distant object and

† The sighting arm would be used in preference to the telescope for observing, when the atmospheric conditions are such that a better view can be obtained by the naked eye than through the glass.

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focus object glass till distant object is clearly defined.

(*e*) Level the instrument by adjusting the legs till the bubble is in the centre of the glass, and secure the legs of the tripod to prevent their shifting.

(*f*) Set the instrument to zero, roughly with the drum out of gear and then exactly with the drum in gear, seeing that both the degree scale on the plate and the minute scale on the drum are at zero.

(*g*) Unclamp the bedplate, and lay the telescope or sighting arm (whichever is being used) roughly on the other instrument if visible, if not visible on the reference point; clamp it, and adjust it exactly on, by the slow motion screw. When the instrument is thus correctly layed, neither the clamp nor the slow motion screw must again be touched. Now take the angle to the "battery director" (*see* p. 68), if visible, and also to the sub-base at the battery, and see that these readings are sent to the battery commander. Then put the drum out of gear and turn the instrument in the direction of the target.

5. The observers will also be instructed in orienting the instrument when at zero on the other observer or reference point, to note the bearing of the instrument when the magnetic needle points north. This information is useful when night firing is to be carried out.

If the target is a single gun, or a well-defined object.

6. Lay the instrument roughly by hand on the target, looking over the sights on the telescope. Put the drum into

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gear and adjust exactly by drum and handle, sending in the reading in degrees and minutes to the battery, by telephone or signal, reading the degrees on the plate and the minutes on the drum (on the scale furthest from the handle). If the target is a disappearing gun, or a gun located by its flash, which is only seen at intervals, several observations should be taken before the instrument is finally set. In that case, the first reliable reading is sent in to the battery in degrees and minutes, and subsequent readings are sent in in minutes right or left of the first reading. The battery commander will communicate an angle at which the instrument is to be finally set. This is called the "clamping angle."

If the target consists of several guns, or of more than one well-defined object.

7. Clamp the instrument on one of the guns, or objects, as in the case of a single gun, and send in the angle in degrees and minutes. Then send in readings for the other guns or objects, in minutes right or left of the first reading. By this means the battery commander will be able to ensure that both observers are clamped on the same point. If the target consists of disappearing guns, or guns only located by their flash, the procedure will be as described in Section 28 (*c*).

If the telescope is being used to observe with.

8. The minutes right or left of this angle at which shell are observed to burst are read by means of the graticules, and sent to the battery.

If the sighting arm is being used to observe with.

9. After the instrument has been set at the angle ordered, the adjustable part of the drum must be adjusted and

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clamped so that the zero on it corresponds with the number of minutes in the angle at which the instrument is set. The minutes right or left at which shell are observed to burst are then measured by traversing the sighting arm by drum and handle on to the burst, and reading the number of minutes on the adjustable drum (if the burst was to the right, reading on the white lines; if to the left, on the black lines), and sending in the number of minutes to the battery. After each observation the instrument must be traversed back to the original angle. When, in observing shell bursts, large angles, say 50′, are read, there is a tendency to bring the zero on the drum back, by traversing through the last 10 of the degree. This alters, and causes an error of one degree in the angle, and can best be avoided by constantly checking the reading of the degree scale, to see that it corresponds with the original angle.

28. *Method of using the observation of fire instruments by night.*

1. Instrumental observation can be carried on by night almost as easily as by day.

The flash of discharge or burst is observed, instead of the smoke; but owing to its instantaneous nature, the telescope and graticules alone can be used to observe with, as the time during which a flash is visible is too short to allow of the sighting arm being traversed on to it with sufficient accuracy.

2. The graticules must be illuminated either by the electric lamp or by a bull's eye lantern held to the small window of the telescope.

Observation at night may be required to be carried on under any of the following conditions:—

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When the night firing follows immediately on the day.

3. In this case it is only necessary to illuminate the graticules and proceed as by day.

When after firing by day, the instruments have been taken down, and must at night be set up as before.

4. The exact position of each leg of the tripods must be marked before they are taken down, by a peg being driven through the hole in the foot.

5. In this case each instrument must be laid at zero as by day, and then set at the same angle as before. To lay at zero on the other instrument, the instrument must be lit up as may be most convenient; but it is important that the method adopted should be such that it can be clearly and easily seen, and not liable to be confused with other lights.

6. The "bearing" of the north point having been registered by day, this angle is set on the instrument and the base plate is revolved until the magnetic needle points north. The base plate is then clamped and the instrument set to zero when the telescope should be on the other observer; but if several observing stations are close together, other means of identification will be necessary, such as different coloured lanterns, or lamp signalling.

7. The inclination of the telescope by day, read in degrees on the arc on the left side and in minutes on the elevating wheel, should be carefully noted, so that time may not be wasted at night in getting the telescope to the proper elevation or depression.

8. On service, instruments should not, as a rule, be taken down, but once they have been correctly set up should be secured in position, and protected from weather by light

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waterproof covers that can be put on the instruments when they are not wanted for use.

When the observation is to commence at night.

9. In this case the target must be a gun or guns whose flash is visible. As in (*b*) the instruments must be marked by lights.

10. If the target is a single gun, the observation is carried out as detailed for day observation.

11. If the target consists of several guns, it is essential that both instruments should be clamped on the same gun.

To ensure this, the battery commander obtains readings to each gun from each observer, and is thus enabled to decide which two readings should refer to the same gun, and orders the observers to clamp accordingly.

12. The procedure will then be as follows :—

The instrument, drum out of gear, is layed roughly, looking over the sights of the telescope, on one of the guns and the drum then put in gear.

Looking through the telescope it is adjusted by the drum and handle so that the target is in *or near* the centre of the field. The angle is then read and sent to the battery. The flashes of other guns are then read right or left of this angle by means of the graticules, and the observation of each *in minutes* is sent to the battery. The battery commander will, as soon as a sufficient number of observations have been received, send the angle at which the instrument is to be finally set. Shell bursts are then observed as before explained.

29. *Other uses of the observation of fire instruments.*

1. The primary object of the observation of fire instruments is to observe fire, and for this purpose the main

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essential is that they should be clamped on the same point in the target. They can, however, also be used for finding the range and line of fire for the battery.

2. In order to do this, it is necessary to determine :—

i. The distance between the observers.
ii. The distance of one of the observers from a director placed in front or rear of the battery—the latter for choice.
iii. The clamping angle of each observer.
iv. The apex angle. That is, the angle formed at the target by the intersection of the line of vision of each observer.
v. The distance of each observer from the target.
vi. The battery range.

These are worked out in the battery by a non-commissioned officer called the "plotter," in conjunction with and under the immediate supervision of the battery commander.

3. It is important to note that the function of the instruments in obtaining these items of information is entirely distinct from their use for observing fire, for which none of this information is essential.

4. The observations of the observers are called out to the plotter by telephonists or signallers who are in connection with them. In doing so, the observer from whom the observation comes and the number of round should always be stated before calling out the observation ; for instance, "Right observer, 5th round 40′ L," &c. Also, in order to prevent confusion from both telephonists calling out together, it is advisable to arrange for one particular observer's result to be called out first, the other telephonist

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waiting till this has been done; preferably, the "line observer's" results should be called out first.

5. Any reliable information regarding the fall of the shot, which might assist the battery commander may be added by the observers to their reports of each round, such as "over and higher than the target," or "much short in valley below target."

30. *Different conditions under which observation can be carried out.*

1. The following are different conditions under which observation may be carried out:—

(*a*) When the observers can see each other.
(*b*) When the observers are unable to see each other.

2. In both the above cases, if a plan of the observing stations, battery, and reference points, is available, the position of the target can be plotted by means of a protractor as soon as the angles to the target are sent in by the observers.

The battery range, apex angle, distance of each observer from target, and, if required, the angle made by the line of fire with the direction of a reference point can then be measured off.

3. The observer who is nearest to the battery line of fire is usually called the "line observer," and will be referred to as such in this section and elsewhere. If both observers are about the same distance from the line of fire, the battery commander will select one of them as "line observer," remembering that the "line observer" should be able, if possible, to see the battery director.

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31. *When the observers can see each other.*

To find the distance between the observers.

1. The observer who is not the line observer, after laying his instrument at zero on the other observer's instrument, swings the telescope round to 90° or 270° as most convenient, and causes a camp colour to be planted in line with the sights of the telescope and any convenient distance from the instrument, measured by tape horizontally from the centre of the tripod head, about 50 feet will usually be found the most convenient distance. This is called the "sub-base."

2. The line observer, having laid at zero on the other observer's instrument, as soon as he sees that the sub-base has been put out, takes the angle to it by traversing the telescope on to the camp colour by drum and handle, and sends in the reading to the battery.

3. Then the formula for finding the distance between observers is :—

$$\frac{\text{Sub-base in yards}}{\text{Sub-angle in deg. and mins.}} \times \frac{\text{Distance}}{90^\circ \text{ (sine scale)}}$$

To solve this on the slide rule.

Set the degrees and minutes on sine scale of slide under the sub-base in yards and over 90° on sine scale read distance in yards.

e.g., suppose sub-base = 60 feet or 20 yards.
sub-angle = 1° 32′.

place 1° 32′ on sine scale under 20 and over 90° on sine scale will be found 747 yards.

Or the following formula may be used instead :—

$$\text{distance between observers, in yards} = \frac{\text{sub-base, in feet} \times 1146}{\text{number of minutes subtended.}}$$

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4. Example :—

Sub-base = 60 feet ; minutes subtended = 92′.

Distance between observers, in yards = $\frac{60 \times 1146}{92}$ = 747.

To solve this on the slide rule :—

Set the minutes in the subtended angle (92), on the slide, under the sub-base, in feet (60) on the rule ; over 1146, on the slide, will be found, on the rule, the distance between the observers, in yards (747).

To find the distance of the line observer from the battery director.

5. The line observer, as soon as he has taken the angle to the sub-base, will keep a look-out for a camp colour held up at the battery director. As soon as he sees it, he will turn his telescope on to it, read off the angle on the base-plate and drum, and send down the actual reading to the battery commander. He will then, in a similar way, take the angle to a camp colour held up at a specified distance from the battery director, and send in the actual reading to the battery commander. The distance between the camp colour at the battery director and the second camp colour referred to is called the "battery director sub-base."

6. It is the duty of the section commander in the battery to arrange for the laying out of this sub-base immediately the director has been set up. He will lay it out with the director at right-angles to the line joining the battery director and the line observer, measuring the distance horizontally. The battery commander, or his plotter, as soon as he has received the angle to the battery director, and the angle to the sub-base at the battery will note them

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on the record form; subtracting one from the other will give him the "angle subtended by the battery director sub-base." He will also note the length of the sub-base in feet.

(He will have informed the section commander what length he wishes this to be, on coming into action.)

7. The distance of the line observer from the battery director is then found in the same way as the distance between observers.

To find the clamping angle of each observer.

8. When the target contains a single definite point, the following is an example :—

From L.O.	*Observations.*	From R.O.
1. 280°. 2′	... ...	1. 88°. 8′
2. 4′ L.	... ...	2. 7′ R.
3. 8′ L.	... ...	3. 2′ R.
4. 7′ L.	... ...	4. 2′ R.
5. 7′ L.	... ...	5. 3′ R.
6. 7′ L.	... ...	6. 2′ R.
Clamping angle for L.O.		Clamping angle for R.O.
279°. 55′	... ...	88°. 10′

9. When the target contains several definite points, such as the flashes of several guns at night, the following is an example :—

From L.O.	*Observations.*	From R.O.
1. Not observed	... ...	1. 96°. 59′
2. 290. 20′	... ...	2. 15′ R.
3. 14′ L.	... ...	3. Line.
4. 15′ R.	... ...	4. 30′ R.
5. 28′ R.	... ...	5. 46′ R.

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The target can be represented as follows :—

From L.O.'s observations.

IV	III	II	I
14′ L.	290° 20′	15′ R.	28′ R.

From R.O.'s observations.

IV	III	II	I
96° 59′	15′ R.	30′ R.	46′ R.

The battery commander wishes to put his observers on to No. 2 emplacement; he therefore orders L.O. to clamp at 290° 35′; R.O. to clamp at 97° 29′.

The apex angle and ranges of observers are now worked out.

10. After the observers have set their instruments to the angle ordered by the battery commander they continue to observe and report as before, and should they find that they are not exactly on No. 2 emplacement they will bring their centre graticules accurately on, at once reporting to the battery commander any alteration they may have made in the clamping angles.

The remaining guns are observed as follows :—

From L.O.	From R.O
6. 13′ R.	6. 16′ R.
7. 1′ L.	7. Line.

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L.O. reports to the battery commander that he has altered 1 L, and sets his instrument 290° 34′.

8.	14′ R.	8.	16′ R.
9.	Line.	9.	Line.
10.	14′ L.	10.	15′ L.
11.	14′ L.	11.	15′ L.
12.	28′ L.	12.	30′ L.

11. Assuming in the above example that the observers are equi-distant from the target the battery commander can, from an analysis, determine the form of the target battery.

The eighth round is fired from No. 1 emplacement, and that gun is either 14′ or 16′ R of No. 2 emplacement, according to whether the line is taken from L.O. or R.O.; it is also further off by the amount due to a decrease of the apex angle of 2′.

The tenth and eleventh rounds are fired from No. 3 emplacement, which is either 14′ or 15′ L of No. 2, and nearer by the amount due to an increase of the apex angle of 1′.

The twelfth round is fired from No. 4 emplacement, which is either 28′ or 30′ L of No. 2, and nearer by the amount due to an increase of the apex angle of 2′.

In the example given in the record of flashes, pages 80 and 81, where the observers and battery are not at the same distance from the target, before determining the form of target battery the readings of the observers must be converted to the equivalent minutes at the battery range.

The readings of rounds 16, 15, 14, and 13 sent in by the observers are;—

	No. 4.	No. 3.	No. 2.	No. 1.
L.O.	27′ L.	13′ L.	Line.	13′ R.
R.O.	29′ L.	14′ L.	Line.	14′ R.

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Setting the plotter's slide rules as explained at that page, we find the equivalent readings at battery range to be :—

No. 4.	No. 3.	No. 2.	No. 1.
L.O. + 32	+ 15	Line.	− 15
R.O. − 32	− 15	Line.	+ 15

which shows that the target battery is one with four emplacements, with a front at right angles to the line of fire.

12. If time is of great importance it is not necessary for the battery commander to wait until all the guns in the target battery open fire before proceeding to find the apex angle and ranges of the observers. The battery commander can proceed to find the apex angle and ranges of his observers before clamping, taking great care that readings from his observers are chosen which, without doubt, refer to the same gun ; or he may even clamp on to any gun, and afterwards change on to another emplacement. It is advisable always to clamp on a central emplacement, as if a flank emplacement is taken there is very little latitude in the field of the telescope for observing shell falling short of, or over, the other flank of the battery.

To find the apex angle.

13. In Fig. 7 let R be the right, and L the left observer and T the target.

Owing to the instruments being similarly graduated, viz., from zero round to the right, the angle LRT will be measured by the right observer and so sent in, but the angle sent in by the left observer will be 360° − TLR. To find the angle TLR, the angle sent in by the left observer must therefore be substracted from 360°. The angles TLR and

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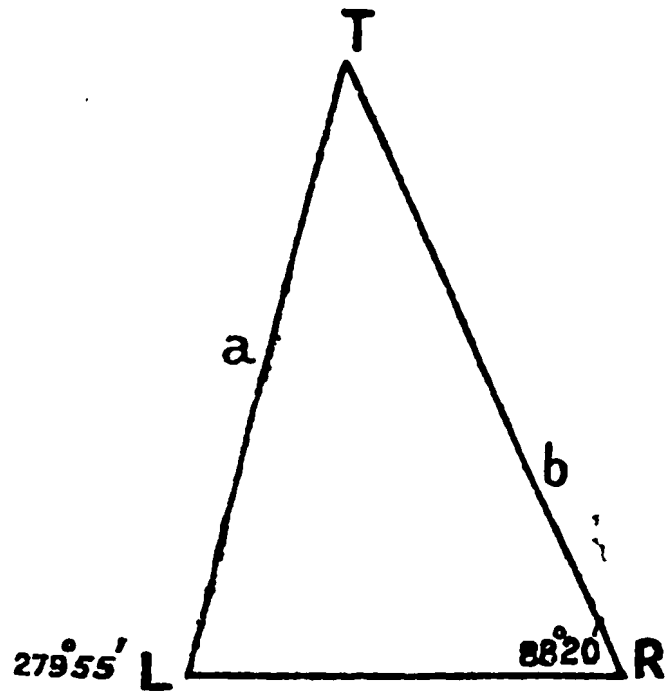
LRT are then added together and subtracted from 180° to find the included angle RTL. Example :—

Angle TLR = 360° — 279° 55′ =	80°	5′
Angle LRT =	88°	20′

Included or apex angle RTL = 180° — 168° 25′ = 11° 35′.

FIG. 7.



To find the distance of each observer from the target.

13. In any triangle the sides are proportional to the sines of the opposite angles.

In the triangle TLR the side LR and the three angles are known. On the slide rule set the sine of the apex angle LTR (11° 35′) under the side LR (603 yards); above the sine of the angle TLR (80° 5′) will be the side RT (2,960

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yards), and above the sine of the angle TRL (88° 20′) will be the side LT (3,000 yards).

If either of the angles at the base is greater than 90° subtract the angle from 180° and take the sine of the remainder.

To find the battery range.

14. The battery range is known when the observers' ranges have been determined, if the battery is quite close to one of them.

If the battery is distant from the nearest observer the battery range can be found by means of the field plotter. This is done at the same time as the angle for the line of fire is calculated, as described in the description of the field plotter (Section 75, Appendix I). But if the line from one of the observers to the target passes through or close to the battery the plotter is obviously not required, the distance from the observer to the battery being merely deducted from or added to the observer's range.

32. *When the observers are unable to see each other.*

1. In this case some mark must be selected or arranged so as to be visible from both observers and on which both instruments can be clamped. This is called a "reference point."

In Fig. 8, let P be the reference point, and L and R the observers. Measure the angle (*a*) at P with a director, sextant or other instrument, and find the distances PR and PL by means of sub-bases in the usual manner.

The angles (*b*) and (*c*) at L and R and the distance LR can be found by means of the field plotter.

2. The instrument at R is then laid at zero on P and the telescope swung round to the angle (*c*). A mark is then

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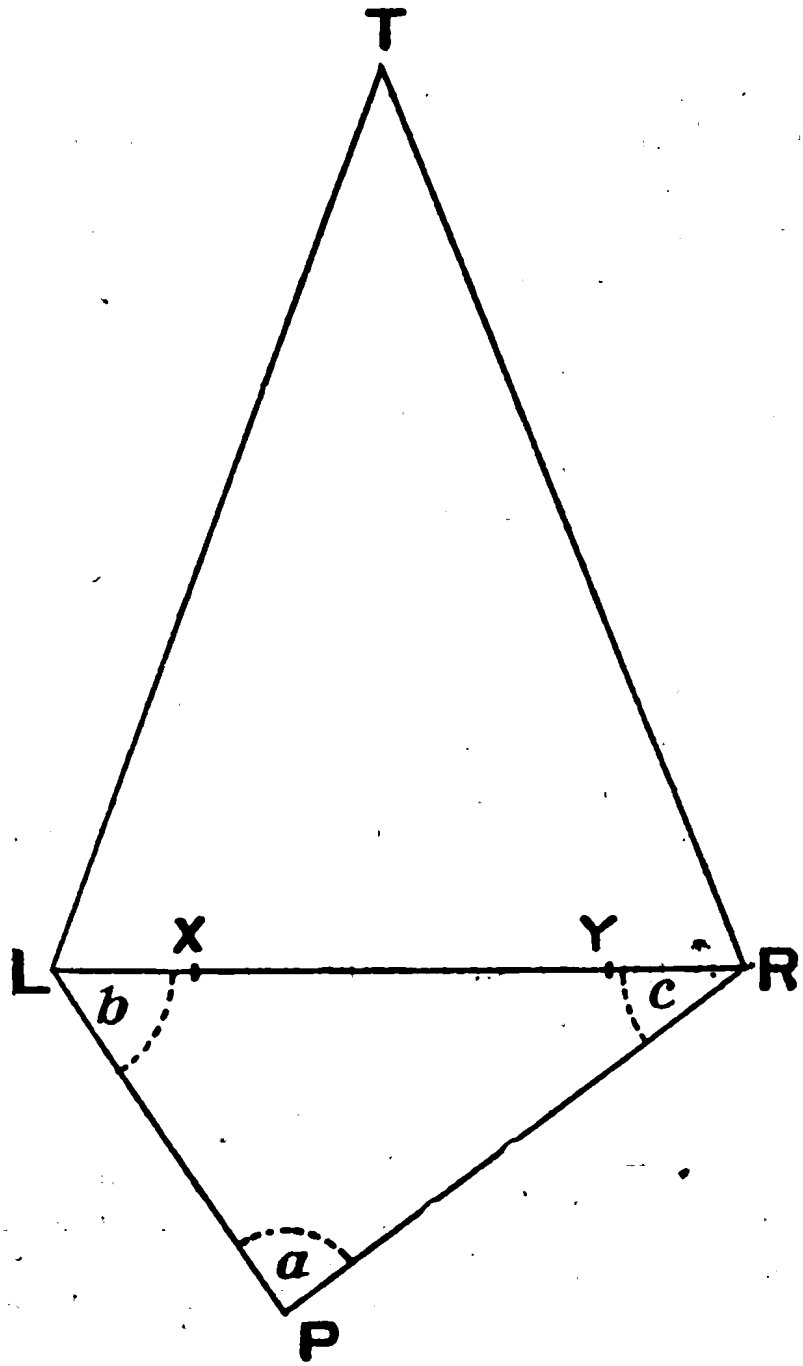
placed at Y in line with the centre graticule of the telescope, and the instrument is laid at zero on Y.

FIG. 8.



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The instrument at L is set at the angle (*b*) and laid on P, and then swung round to zero. A mark is then placed at X in line with the centre graticule of the telescope.

Each instrument is now practically laid at zero on the other, and the method described in Section 31 (*a*) is applicable for all targets that can be seen by the observers.

The marks at X and Y remain, and can be used to check at zero at any time.

3. These operations are only necessary when it is intended to make use of the instruments to find the range and line of fire, or to employ an apex angle in ranging.

4. As will be seen in the chapter on ranging, the knowledge of the apex angle in most cases merely enables one or two rounds of ammunition to be saved.

Consequently, when other means of finding the range and line of fire are available (as they usually would be), much time would be saved, when the observers are unable to see each other, by merely ensuring that they are clamped on the same part of the target (which is all that is necessary for the purpose of *observing*), and discarding the rest of the procedure described.

5. An appreciation of the above facts is of importance to battery commanders, as it admits of their selecting observing stations with a view to their facilities for observation, without attaching undue importance to the possibility of the observers seeing each other.

33. *Aerial Observation.*

1. In addition to "visual" and "instrumental," observation may be carried out from aeroplanes or kites.

2. When observation is from an aeroplane a single round is fired from the battery, after the target has been indicated, and the aeroplane should report by signal the line and range,

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these may be corrected separately, but it is possible to correct both simultaneously. When the line and range have been found the aeroplane may be used to correct the fuze.

3. Very's lights form the best means of signalling from the aeroplane to the ground, and strips of cloth, wood or metal, cut into letters 4 feet high and painted white and placed on a black background, form a good means of communication from the ground to the aeroplane.

The aerial observer can also signal to the ground by means of the Klaxon horn, but no such signal can be audible in an aeroplane when sent from the ground.

4. With Very's light the following code of signals will be used :—

(*a*) Before fire is commenced—

One green light ... "I am ready to observe fire."

(*b*) While ranging—

Light used.	For line.	For range.	For fuze.
One red.	Right.	Over.	Air.
Two red.	Far right.	Far over.	. . .
One green.	Left.	Short.	Graze.
Two greens.	Far left.	Far short.	. . . . .
One red, one green.	Line.	Range.	Fuze correct.
One green, one red.	Unobserved.	Unobserved.	Unobserved.

A signal of a single light will be accompanied by one blast on the Klaxon and one of two lights by two blasts.

The signal "Far right" or "Far left" should be made when the shell bursts 2 degrees or more from the target, and "Far over" or "Far short" when the shell burst is 200 yards or more from the target.

"Fuze correct" will be signalled when the shells burst in air and on graze in proportion of 4 or 5 to 1.

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(*c*) After fire for effect has commenced—

One red and one green light	Fire effective.
A white light fired at any time means ...	"I am about to drop a message."
Two white lights mean	"I am about to land."

Signals from the aeroplane will be acknowledged by a white square placed on a black background.

5. The following code will be employed for use with the letters placed on the black background for signals to the aeroplane from the ground :—

I.	Indicate target.
L.	Observe for line.
X.	Observe for range.
LX.	Observe for line and range.
Z.	Observe for fuze.
V.	Observe for general effect of fire.
N.	Repeat last signal.
T.	Land.

All letters should be placed on the ground so that the top of the letter is towards the target.

All signals from the ground should be acknowledged by a series of short blasts on the Klaxon.

6. The general procedure will be that a landing place will be selected and telephonic communication will be established between this place and the battery commander.

When the aerial observer has located a suitable target he will land and describe the general position of the target through the telephone or by means of a map (*see* Chapter III, Section 12).

He will then ascend and fire a green light when ready to observe. He will then fly up and down the line of fire.

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The battery commander should arrange to fire his guns when the aeroplane is travelling towards the target. If the instructions are to "observe for line" only the observer will fire the signals as shown above according to the fall of shell; if, however, the instructions are to observe for "line and range" all signals fired during the time that the aeroplane is travelling towards the enemy will be taken as referring to line, and those fired while the aeroplane is travelling away from the enemy will be taken as referring to range. In this method if the aeroplane starts in rear of the guns a round may be fired when it is over the battery, the aeroplane should signal the line, turn at once and signal the range, and proceed to the point in rear of the guns and turn ready to observe the next round. The length of the course will depend on the time taken to load and relay the gun.

7. When a round is reported range it may be possible for observers to clamp observation of fire instruments on the shell burst and for the battery commander to carry on instrumental observation.

8. Two observers should be detailed from each battery to watch the observing aeroplane, one with low power field glasses looking out for the signals, the other with his naked eye keeping a continuous watch on it so as to make certain that no mistake is made as to the actual machine, since when there are several aircraft in observation, confusion between them is very likely to arise.

9. When kites are available the results of the observation can be telephoned down to the guns and there is no waste of time, but they can only operate in a wind and their range of vision and power to see behind cover is limited.

The enemy will have less difficulty in hitting a kite than an aeroplane, but, on the other hand, the observer can use

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graticuled glasses, and his reports should be more accurate than any that can be expected from an aeroplane.

Army Form B 297-2.

OBSERVER'S RECORDS.		(9) TARGET or FLASHES.			
1. Name		1. N.O.	11.	13′ L.	N.B.—Corrections for line to the extent of 2 mins. only to be made by the Observer.
2. Left or Right Observer	Left	2. 290° 36′	12.	28′ L.	
3. Laid at Zero on	R.O.	3. 9′ L.	13.	13′ R.	
4. Elevation or depression of telescope		4. 24′ L.	14.	Line.	
5. Length of sub-base put out	50 feet	5. 17′ R.	15.	13′ L.	
6. Angle to other observer's sub-base or reference point base		6. 4′ R.*	16.	27′ L.	
7. Angle to battery director (or dial sight)		7. 13′ L.	17.		
8. Angle to battery director sub-base		8. 27′ L.	18.		
		9 13′ R.	19.		
		10. Line.	20.		

10. Final clamping angle after rd. 6. 290° 40′. * Clamp at 290° 40′
11. Elevation or depression of telescope to target.
12. **SHELL BURSTS.**

1.	12′ R.	11.	21.	31.
2.	5′ L.	12.	22.	32.
3.	17′ L.	13.	23.	33.
4.	21½′ L.	14.	24.	34.
5.	19′ R.	15.	25.	35.
6.	2½′ R.	16.	26.	36.
7.	13′ L.	17.	27.	37.
8.	30′ L.	18.	28.	38.
9.	17′ R.	19.	29.	39.
10.	1′ L.	20.	30.	40.

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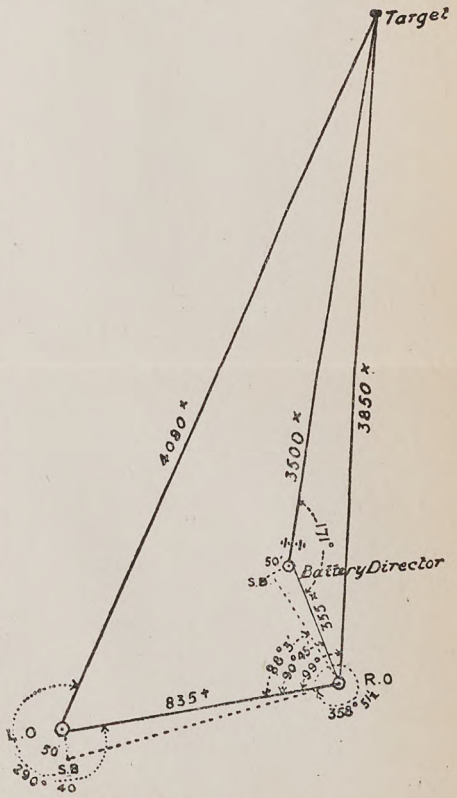
PLOTTER'S RECORD. Army Form B 297–3.

Date _____ Series No. _____ Company _____

	L.O.	R.O.
Angle to observer's sub-base		358°51½′
Length of observer's sub-base	50′	
Clamping angle	290° 40′	99°
Angle to battery director ...		90° 45′
Angle to battery director sub-base		88° 3′
Length of battery director sub-base		50′
Angle of sight to target ...		
Angle of sight to battery director		



Line Factor (if required) _____

READING OF SHELL-BURSTS.

No. of Round.	Observed from L	O	R	O	Result given to Battery Commander.
	Left.	Right.	Left.	Right.	
1	+	12 — 14	—	18 + 20	20′ R + 6
2	5 + 6	—	2 — 2	+	2′ L + 4
3	17 + 20	—	21 — 23	+	23′ L — 3
4	21½ + 25	—	27½ — 30	+	30′ L — 5
5	+	19 — 22	—	15 + 16	16′ R — 6
6	+	2½ — 3	—	Line + Line	Line — 3
7	13 + 15	—	10 — 11	+	11′ L + 4
8	30 + 35	—	29 — 32	+	32′ L + 3
9	+	17 — 20	—	20 + 22	22′ R + 2
10	1 + 1¼	—	7½ — 8¼	+	8′ L — 7
11	+	—	—	+	
12	+	—	—	+	
13	+	—	—	+	
14	+	—	—	+	
15	+	—	—	+	
16	+	—	—	+	
17	+	—	—	+	
18	+	—	—	+	
19	+	—	—	+	
20	+	—	—	+	

FOOTNOTE.—The original report by observer should be entered on the left of the + and — signs, and its correction to Battery range on right of the same sign.

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Army Form B 297-4.

RECORD OF FLASHES OF HOSTILE GUNS.

Date _____ Series No _____ Company _____

No.	Left Observer	Right Observer
1	N.O.	99° 15′
2	290° 36′	15′ L
3	9′ L	29′ L
4	24′ L	45′ L
5	17′ R	1 L
		clamped at 99
6	4′ R	Line
	clamped at 290° 40′	
7	13′ L	14′ L
8	27′ L	29′ L
9	13′ R	14′ R
10	Line	Line
11	13′ L	14′ L
12	28′ L	30′ L
13	13′ R	14′ R
14	Line	Line
15	13′ L	14′ L
16	27′ L	29′ L
17		
18		
19		
20		
Final Clamping Angle.	290° 40′	99°

Form of Target as indicated by flashes :—4 Gun Battery.

32 L Range.	15 L Range.	Line Range.	15 R Range.

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34. *The record of observation.*

1. Each observer keeps a record of his observation on Army Form B 297-2, *see* p. 80.

On the Plotter's Record, 297-3, and Record of Flashes, 297-4, is recorded all the information received from the observers.

2. The accompanying examples of A.F. 297–3 and 297–4 show a target consisting of four guns, located by their flash :—

(*a*) After the fourth observation the battery commander directs the right observer to clamp at 99°, but the message is not received till after the observer has recorded the fifth observation.

(*b*) After the sixth observation the battery commander directs the left observer to clamp at 290° 40′.

The apex angle and distances of observers from the target are then found.

The plotter's slide-rules are set as follows :—

That for the left observer with 3500 on the slide under 4080 on the rule, and that for the right observer with 3500 on the slide under 3850 on the rule.

In recording shell bursts.

3. For the first round the left observer sends in 12 minutes right the plotter writes down 12 on the left of the – sign in the third column, looks to 12 on left observer's slide and finds above it 14, and writes down 14 on the right of the – sign. The right observer sends in 18 R, the plotter writes down 18 on the left of the + sign in the fifth column, looks to 18 on the right observer's slide and finds above it 20, and writes down 20 on the right of the + sign.

4. The plotter then writes down in the column of results 20 R, which is the corrected line from the right observer,

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viz., the observer who is nearest to the line of fire, and + 6, which is the amount that the base angles have been increased and consequently the apex angle decreased and the shell has fallen over. For correcting result to battery line when necessary, *see* p. 110.

Each shell burst is similarly filled in and reported to the battery commander, until the latter orders the plotter to give only + and −, without stating the amount. This will usually be after the third round.

35. *Instructions for observers.*

1. Observers should make sure that they are in the best position for observing, and also that they make the best use of available cover. If they find that there is in the vicinity a better position than the one originally selected they should go there and report to the battery commander that they have done so.

2. Observers should always telephone in, and note on their record a full description of the target as it appears from their position, and of the nature of ground on which it is situated. Such as :—

A. Target an emplacement containing guns slightly in rear of crest of hill ; hill itself a ridge about half a mile long and apparently about 100 yards broad on top, running obliquely across the front of our battery. Two guns visible from my station, about 10 minutes apart. Open ground in front, sloping gradually towards valley about half a mile below. Observation reliable to front and flanks, but unreliable beyond target.

B. Target a line of shelter trench, apparently about 200 yards in length, on centre of ridge. Ground sloping steeply down to the front and flanks, rising gradually beyond the target. No well-

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defined point on which to clamp. Observation reliable in rear and near target, but unreliable to front or flanks.

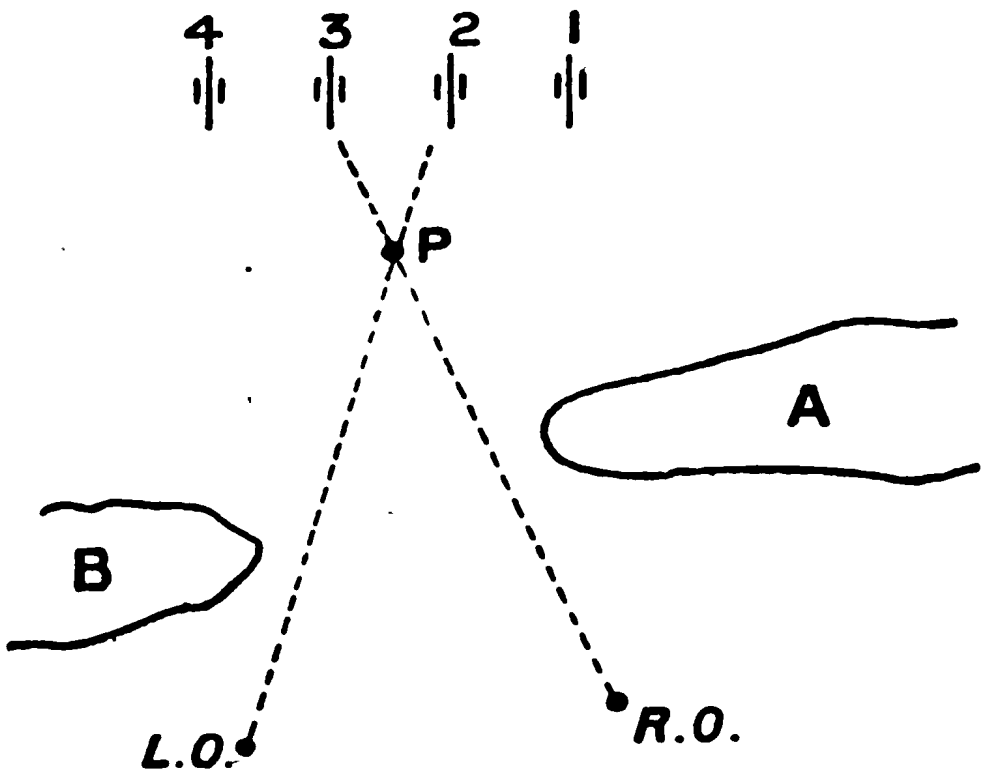
Such information is of great use to a battery commander—so much so that in such a case as the second one he would probably order the observer to send in + and − only, and himself go to a position from which he could observe the line.

3. The reading of any angle should be checked, if possible more than once, before sending it in. An observer must be certain that he is clamped on the exact part of the target ordered ; otherwise he must report that he is doubtful.

4. When sending in readings to several objects, such as guns in battery, be always careful to report if the field of view is not entirely clear.

The following example will explain what is meant :—

Fig. 9.



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In Fig. 9, the target consists of four guns, 1, 2, 3, and 4. A and B are clumps of trees, buildings, high ground, &c. The right observer (R.O.) can see three guns, 2, 3, and 4; and the left observer (L.O.) can also see three, 1, 2, and 3.

If each observer were only to send in the readings of each of the guns which he could see, the battery commander would conclude that they were the same three guns, and would clamp the right observer on No. 3, and the left observer on No. 2—with the result that the ranging would be carried out on a point, P, some distance short of the target.

But if the right observer reported, in addition to the readings to the three guns which he could see, that his view to the right was obstructed, while it was all clear to the left, and the left observer reported that his view to the left was obstructed, while it was quite clear to the right, the battery commander would endeavour to find out, by reference to the brigade commander, or by independent observation, the number of guns in the target, and would then be able to clamp his observers on to the same gun.

This is rather an extreme case; but similar difficulties in a modified form constantly occur.

5. If after clamping on the target there is any suspicion that the instrument has moved, traverse back to zero and see if the instrument is properly laid as it was before. If it is not, report it, relay at zero and recheck.

6. Observe quickly; the smoke from a bursting shell rapidly drifts with the wind, and it is most important to observe it the instant it appears.

7. Observe the flash whenever possible, otherwise the *centre* of the smoke, the observations of different parts of it by the two observers, will lead to considerable error.

8. Send in all observations to the battery with as little

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delay as possible. In case of any doubt as to the absolute accuracy of an observation report it as "doubtful." Always send some information as to the fall of the shell: if not in the field of the telescope, report whether "much right," or "much left," and if an estimate can be formed as to how far right or how far left report the amount estimated.

9. If the target is on uneven ground always report the fact if a shell fall on higher or lower ground than the target; and when the ground is steep give an estimate as near as possible of the number of minutes that the shell falls above or below the target.

10. When a shell falls obviously either over or short of the target the fact should be reported, in addition to the amount right or left.

11. Sometimes negative information is of value—for instance, a shell may burst out of view altogether, and from the fact that all the ground short of, or all the ground beyond the target is visible, it may be clear that the shell could not have been short or could not have been over. When this is so beyond doubt, it should be reported.

12. Finally, it cannot be to strongly impressed upon observers that they should send in any information they may obtain as to the target, and they should not be under the impression that they are *only* required to send in observations right or left.

For instance, when firing at a battery of guns, one of them may be dismounted; or they may be reinforced by more guns; or they may be slightly withdrawn or advanced. Other events of importance to the general situation (not necessarily having reference to the target) may be also noticed.

All these things must be reported: and their importance points to the advisability of the battery commander himself

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taking up his position near one of his observers whenever possible, provided he can retain complete control of his battery.

The following are examples of reports of the observation of rounds :—

(*a*) Unobserved, but certainly not short.
(*b*) Over and higher than the target.
(*c*) Much short in valley below target.
(*d*) 50′ R. and about 20′ low.
(*e*) 50′ R.
(*f*) 25′ R. and range. Hit the flank gun.
(*g*) Line and over. Apparently struck ammunition wagon. Two guns are retiring, and one of the remainder is out of action.

And so on.

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CHAPTER VI.

RANGING.

36. *General instructions.*

Ranging is the process of determining the correct elevation and deflection to be given to a gun or howitzer, so that the mean point of impact shall be on the target; and also, when firing shrapnel, of finding the length of fuze that will give the most effective result.

When the battery commander has given an order to load with any nature of projectile, that loading will be continued until an order to change is given.

As a rule, with howitzers, the largest charge that will give the requisite angle of descent, if such is a consideration, will be used.

If the target is a wide one, distribution of fire over the front of it should always commence as soon as possible.

When using "visual" observation it will often be advisable, if the target is a difficult one, to select the most conspicuous part of it to range upon, and not to distribute the fire until the range has been found. (Example IV.) Except when such is the case, distribution should commence from the first round.

When using "instrumental" observation, distribution of fire will usually commence from the first round. (Example II.)

The conspicuous part of the target selected to range upon is called a "ranging point."

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When using "instrumental" observation, the term "ranging point" is used in connection with distribution of fire to indicate (with reference to the point on which the observing instruments are clamped) the exact portion of the target on to which it is intended to direct the fire of each gun.

With visual observation of fire great care must be taken in judging whether a shell falling on ground either above or below the level of the target was fired at too great or too small an elevation. Thus, if the ground to the right of the target slopes into a ravine or valley on that side, a round which would have been short if in line might travel a considerable distance beyond the target if it fell much to the right on the lower ground, and if a shell fell much to the left on the ground higher than the target and was short, it might very well have been over had it been in correct line with the target; in both these cases, therefore, the record of the round should be marked doubtful, the line corrected, and the round repeated with the same elevation as before. In the reverse case to the above, that is, when the shell on the lower ground is obviously short, and that on the higher ground is obviously over, no doubt can exist, both must have been a good deal short and over respectively, and correction may be made on them.

When the ground on which the target is situated is boggy, cut up by ravines or wooded, and when the ground rises or falls sharply on either side of the target, there is a great probability that time and ammunition may be wasted on account of the necessity for repeating rounds from the causes already mentioned. For this reason, and also owing to the probability of there being some slight inaccuracy in the laying out of the line of fire, it will often be advisable to give some deflection to ensure that the first round shall

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fall on any open ground which may exist near the target. By this means the shell can, at any rate, be observed instead of possibly disappearing altogether, and this enables the line, at least, to be corrected. It may also be possible to form an estimate as to whether the round was + or —.

It may even be advisable, when firing from behind cover, and the bursts of percussion shell cannot be located, to fire a round of time shrapnel with a short fuze. This will enable the line of fire to be corrected should there be any error in it.

There are various considerations which govern the elevation at which the first round should be fired, viz. :—

When there is a considerable extent of level ground both in front and in rear of the target, the first round should be at the elevation due to the range as estimated or found.

When the target is at or near the crest of rising ground, and there is an expanse of ground visible in front of it, a less elevation (say the length of the long bracket) than that due to the range should be given ; this is to ensure observing the first round and at least correcting the line, which could not be done if the shell went over the crest. The same procedure should be pursued when the ground in front of the target can be seen to be favourable for ranging, but there is less certainty about that in rear.

For similar reasons to those in the last paragraph, a greater elevation than that due to the range should be given when the ground rises steadily in rear of the target, but that in front of it is broken by ravines or other obstacles which might conceal the position of the fall of the shell, or, when an intervening ridge obscures most of the ground immediately in front of the target. (Example IV.)

All these are matters of experience and judgment, but the battery commander who gives them attention will be repaid,

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as nothing is so perplexing as when the fall of the first round is entirely lost to view.

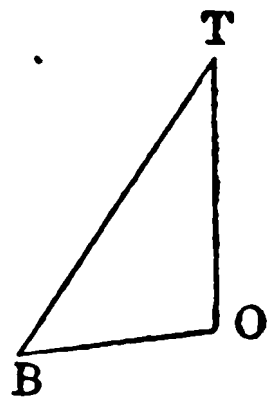
When laying with clinometer elevation, the angle of sight must be allowed for if the target is not on the same level as the gun : that is to say, the angle of sight must be added to the elevation due to the range if the target is on a higher level than the gun, and must be subtracted if the target is on a lower level than the gun.

If the target is visible from the gun the angle of sight may be measured by laying the gun with the sights set at zero (on the degree scale) on the target, and then measuring with a clinometer the angle of elevation or depression at which the gun is. As a rule, this will not be possible, and then the angle of sight will be measured by means of a director or observation of fire instrument.

If necessary, the angle of sight may be found by calculation from information obtained from one of the observers. To do so, the observer measures the angle of sight to the target, and also to the battery. Then the angle of sight from the battery

to the target is equal to $\frac{e \times OT - e^1 \times OB}{BT}$

where e = angle of elevation from O to T,
e^1 = " " " O to B,
OT = distance from observer to target,
OB = " " " battery,
BT = " " battery to target.



If any of these angles is one of depression, it is read as minus.

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37. *To find the elevation.*

With howitzers possessing both a high explosive shell and a shrapnel shell which will be used against different natures of targets, the limits of the accuracy to be obtained in ranging for elevation will vary according to which nature of shell is being employed. Great accuracy will be necessary in the case of common shell, where the effect on any target involving the employment of this nature of shell will depend on obtaining direct hits.

With shrapnel shell the same degree of accuracy is not essential owing to the comparatively large area covered by the spread of the bullets, and the process of ranging for elevation therefore will vary, depending on which nature of shell is being employed.

The actual process of ranging for elevation will vary also with the different methods of observation of fire which may be employed.

Ranging is either "Single gun," "Section," or "All guns," high explosive common shell or percussion shrapnel being employed.

By "Single gun," "Section," and "All guns ranging," is meant ranging with one, two, or all guns fired singly.

In "All guns ranging" a single initial elevation is ordered, subsequent elevations being given out singly on the observation of the previous round.

In "Section ranging" two elevations are ordered with or without an interval.

In "Single gun ranging" either of the above two methods may be followed, but only one gun is used.

During the process of ranging the order for elevation (or elevations) by the battery commander is the notification to fire the next gun (or guns) when ready, and if he does not

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wish to make any alteration in elevation he will order "Repeat."

The fall of the shell is judged when visual observation of fire is being used from the smoke of the burst of the shell showing either in front of, or behind the target. It is, therefore, of the utmost importance to correct the line at the earliest moment, so that the shell may burst in the best position to enable the smoke to afford correct conclusions to be drawn. Except under the most favourable conditions for observation, it is almost impossible to judge the fall of a shell as regards range unless it is in line with the target, and the danger of accepting untrustworthy evidence in this respect is specially to be guarded against. (Example III, Rd 1.)

38. *Ranging for elevation with visual observation of fire.*

Under service conditions it is seldom possible to estimate with accuracy the distance the burst of a shell is short or over with regard to the target. The principle of ranging for elevation is therefore to find two elevations the longer of which will throw the shell beyond and the other short of the target, thereby enclosing it in what is called a bracket.

This bracket may vary in size according to the accuracy with which the range is believed to be known, but it will be large at first and be termed then the "long bracket." It will subsequently be reduced to narrower limits by decreasing the difference between the elevations with successive rounds, until what is known as the "short bracket" is obtained.

The difference between the two elevations constituting this "short bracket" will vary according to the nature of shell being employed.

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If percussion shrapnel are being used with the intention of resorting to time shrapnel as soon as the range is found the "short bracket" will be the nearest convenient equivalent in minutes to 100 yards. (Examples III, IV and V.) This short bracket should be used if high explosive shell are employed temporarily during ranging to facilitate observation by the greater amount of smoke they produce.

If high explosive common shell only are being used the "short bracket" should be the nearest convenient equivalent in minutes to twice the 50 per cent. length zone of the gun at that range. (Example I.)

With visual observation, ranging will as a rule be "section ranging," though under certain conditions, such as ranging on the line of observation, it may be advisable to use "single gun ranging." (Example III.) As this system involves the giving out of elevations in pairs and the principle of interpolating between the elevations ordered, it follows that the "long bracket" will be three times (or multiple of 3, such as 9 (Example I); or in the case of small short brackets 27) the value of the short bracket, whatever nature of shell is being employed. As a rule the "long bracket" which should constitute the initial elevations ordered will be the nearest convenient equivalent to 300 yards. With shrapnel shell if this long bracket is successful, one interpolation should ensure the short bracket being found; but with high explosive common shell only, three times the "short bracket" representing twice the 50 per cent. length zone may not be sufficient to ensure a suitable long bracket being obtained, and the above rule as regards multiples must be observed and initial elevations differing by nine times the short bracket may be necessary. The initial elevations should be given out suitably on either side of the elevation due to the range, with any corrections that

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may be necessary for angle of sight, wind, or other causes, and also with regard to the facilities for observation short or over the target to enable the line to be corrected if necessary at the earliest moment. They will also be given out at first to the nearest degree or half degree.

Having obtained the short bracket as explained above, the procedure will vary according to whether time shrapnel is going to be resorted to, or high explosive shell continued.

With shrapnel the ends of the short bracket will be verified, and it is important to make certain of this bracket. The mean of this bracket will be the elevation for which the fuze will be found subject to any correction for angle of sight. Any further small corrections to the range will be made on the results of the observation of shell bursting on graze or the splash of the bullets, if such can be observed. It is seldom worth while to make a smaller change of elevation than the equivalent of 25 yards.

With high explosive common shell only (Example I), a verifying series of four rounds will be fired throughout the battery at the mean of the short bracket, and a correct proportion of two plus and two minus should be obtained.

Each gun will then be verified separately by firing groups of four rounds when the correct proportion of plus and minus rounds should be maintained. If the verifying group fired throughout the battery gives an incorrect proportion, a correction to the elevation equal to half the short bracket will be applied in the required direction, and each gun will be verified on its own account with the corrected elevation as above.

If at any time the first three rounds of a verifying group are all plus or all minus, the fourth round will not be fired as a correct proportion could not ensue in any case.

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If a shell is observed at any time during the process of ranging to strike the target, the verifying series throughout the battery may be fired at that elevation. Similarly, when firing shrapnel, if a hit is observed on the target during ranging, a pair of verifying rounds should be fired with elevations differing by the amount of the short bracket, one above and one below that giving the hit, before proceeding to range for fuze.

With either nature of shell, if the whole series depends on the correct observation of a single round, that round should be repeated and another fired with more (or less) elevation equivalent to the short bracket.

In all cases in section ranging, where two elevations are ordered, the higher elevation is given out first and is fired first by the right hand gun of the section and the lower by the left gun, at an interval of 30 seconds unless otherwise ordered. As a rule it is advisable to order an interval between the initial rounds greater than the time of flight, so that, in the event of the first round falling minus or too wide of the target to permit of its correct observation, a round may be saved or the line corrected. In such a case the battery commander will give the order "Stop" which will be followed by the order "Go on" as soon as the fresh elevations or corrections for line have been given out. (Example IV, Rd 3.)

When the target is only visible from one position, and that some considerable distance to the flank of the battery (Example IV), it is necessary that the ranging rounds shall fall in line with the observer and the target to facilitate observation. Should the target be a narrow one, the alteration in deflection required to do this for an increase or decrease of say 300 yards should be calculated, whereby it is easy to determine at once any correction in deflection

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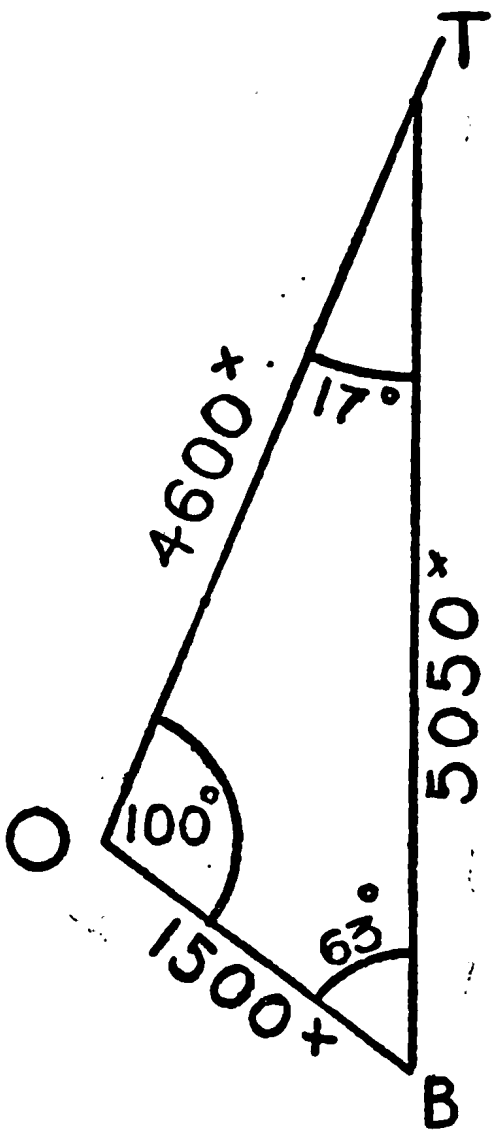
necessary for any change in elevation during the process of ranging.

FIG. 10.



This calculation can be made by means of the field plotter in the following manner. From the nature of the circum-

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stances the line of fire will probably have been obtained with the field plotter and the battery angle and battery range found thereby. The battery range as given on the instrument should be increased or decreased by 300 yards, and this range put on the range arm.

The plotter should then be turned over and the included angle reset as before. On again reversing the plotter the new battery angle will be read, and the difference between this and the old will be the deflection correction required to keep a round falling on the line of observation if the elevation has been altered by the equivalent of 300 yards. Proportional correction for any required change in elevation can then be calculated readily.

The above diagram shows the relative positions of battery, observer, and target, and the details of angles and ranges obtained in the process of laying out the line of fire.

If the plotter is set with 5,350 yards on the range arm and the angle TOB reset at 100°, it will be found that the battery angle TBO is now 64°.

1° of deflection is necessary therefore for a change of elevation of 300 yards in order to keep the shell falling on the line of observation OT, once such a result has been obtained. It is obvious that more right deflection must be given for an increase of range and *vice versâ*.

A convenient scale in this case is 20′ deflection for a change of 100 yards in elevation.

In such a case at a narrow target it is advisable to employ "single gun ranging" when elevations may be given out either singly or in pairs, but only a named gun will fire. The target will be bracketed in the same manner as in "section ranging," and as soon as the short bracket has been verified the battery commander will order "parallel lines" to the ranging gun.

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39. *Ranging for elevation with the aid of instrumental observation.*

Under certain circumstances, and if time permits, the system of instrumental observation of fire, as described in Chapter V, has to be employed by the battery commander to assist him in ranging, and in such cases "all guns ranging" will always be the process to be adopted. (Example II.)

As has been shown in Chapter V, the battery commander is enabled to obtain very accurate information as regards the fall of each round when this system of observation is efficiently carried out, and it is therefore particularly applicable to such cases where the employment of high explosive shell is necessitated with the consequent extreme accuracy in ranging. The "short bracket" to be obtained will be the nearest convenient equivalent to twice the 50 per cent. length zone of the gun at the range, similar to the "short bracket," previously described when ranging with H.E. shell with visual observation of fire. In describing the procedure with instrumental observation of fire it will be considered that high explosive shell is the normal projectile to be employed.

The system may be generally described as a combination of the two methods of making exact corrections to follow the exact information the battery commander is given as regards the fall of the round, and the more inexact corrections to ensure a bracket being obtained. With visual observation the battery commander can normally form no opinion as to the amount the shell has fallen over or short, whereas with instrumental observation and assuming that the shell has fallen not very far from the correct line, he will receive very fairly accurate information as to this amount, and his corrections for the first observed round can

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be based upon this information. To continue to apply the method of making exact corrections to the fall of each round might produce apparently very contradictory results, and therefore it is preferable to make exact corrections until a bracket has been obtained, and then to continue on the bracketing principle, regarding each subsequent round as only plus or minus, and as described under ranging with visual observation of fire.

To enable the system of making exact corrections to merge conveniently into the system of bracketing, the value of the short bracket should not be lost sight of when making exact corrections. Therefore when a round has fallen comparatively near the target it is preferable to extend the amount of the exact correction so as to ensure a bracket, and it follows that the bracket so obtained will often either be the "short bracket," or a very near multiple of it from which point the bracketing principle will commence.

The term "exact correction" is only a comparative one, and the elevation ordered should always be given in convenient degrees and minutes.

The procedure may be described more in detail as follows :—A round is fired. The observations are telephoned or signalled in combined by the plotter, and the result entered in the battery ranging sheet by the battery commander's assistant as so many minutes of apex angle over or short. The battery commander converts this into minutes of gun elevation by means of the factor $\frac{5\ R}{n\ A}$, and if this result is large compared to the short bracket he will order a fresh elevation based on the exact correction necessary (in convenient degrees and minutes). If the result is small compared with the short bracket he will still base the fresh elevation on the exact correction necessary, but will

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order one that will ensure getting a bracket, and at the same time have regard to the value of the short bracket and the simplification of future sub-division in the event of the result of the next round enabling him to proceed on the bracketing principle.

Once bracketing is commenced the battery commander may disregard amounts and merely consider rounds as plus or minus, though the plotter and battery commander's assistant will continue to register the amounts in their respective forms for the battery commander's information if he should require them. This will continue until the short bracket is obtained and the procedure is the same as that described in ranging with visual observation.

If at any time a round is plotted as being well within the distance, equal to the 50 per cent. length zone measured from the target, the fact should be reported to the battery commander, and a verifying series through the battery may be fired at that elevation (Example II, Rd. 3), but if subsequent rounds show this round to have been abnormal, bracketing should be recommenced.

In "all guns ranging" the initial elevation will be given out to the nearest 20′, 40′ or whole degree, except when the short bracket is equivalent to 30′, when it will be given out to the nearest degree or half degree.

Ranging with the aid of instruments, as here explained, has been carried out on the assumption that the apex angle is known. But if this angle cannot be ascertained (as, for instance, when the distance between the observers is not known, and cannot be found) the instruments may still be of use in ranging, provided they can be clamped on the same spot in the target. The observers' results will then be recorded as so many minutes of apex angle over or short of the target, and the only difference will be that it

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will not be possible off-hand to convert these minutes of apex angle into yards of range. This may result in one or two more rounds being required, but otherwise it does not affect ranging, carried out as ranging now is by the bracket system.

It follows from this, that whenever two telescopes provided with graticules can be clamped on the objective, they may be made use of for ranging without any knowledge of the range, apex angle, or distance of the observers from the target or from each other.

Example :—

No. of Round.	Elevation.	Plotter's Report.
1	20°	+ 60 minutes.
2	16°	+ 10 „
3	15°	− 1 „

In this case a drop of 4 degrees in elevation shortens the range by 50′ of apex angle, and a drop of 1 degree decreases the range by 11′ of apex angle. Therefore 1′ of apex angle represents, in round numbers, 5′ of elevation. The range table will show what 5′ in elevation represents in yards at this range, and consequently the number of yards represented by 1′ of apex angle. Supposing the short bracket to be 30′, the third round is well within the 50 per cent. length zone, and a verifying series might therefore be commenced at the elevation of 15 degrees.

39A. *To find the fuze.*

The battery commander after ranging for elevation will find the fuze by firing an echelon from the three right guns

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of the battery from right to left at 5 seconds interval unless another interval is ordered. In ordering the initial fuze the battery commander will correct the verified elevation by the angle of sight, and should endeavour to select from the fuze scale an echelon which will give bursts in air and on graze.

It should be borne in mind that an altitude of 1,000 feet above sea level, or one inch fall of barometer, requires a reduction of the fuze length by one-thirtieth. (Examples IV. and V.)

The increment should be a fuze alteration which most nearly corresponds to 100 yards at the range.

The order will be "Echelon ..... increase ..... Elevation....."

On this order the No. 1 of No. 1 gun orders his fuze to be set at the length named, the Nos. 1 of Nos. 2 and 3 order their fuzes to be set at a successive increase of the increment named.

It may in very exceptional circumstances be necessary to fire a second echelon.

To obtain effective shrapnel the mean height of burst with the 6-inch B.L. howitzer at all ranges should be 25 minutes above the line of sight.

This height of burst should theoretically give not more than 10 per cent. grazes. It should be borne in mind that one-quarter division alteration of fuze length raises or lowers the burst 10′ with reference to the line of sight.

39B. *To correct the line.*

With visual observation of fire ranging for deflection is carried out as follows :—

If the first observed shell falls wide of the target by more

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than the amount of the 50 per cent. breadth zone, the battery commander will as a rule give to "all guns" a sufficient estimated correction to bring the next shell on to the target; for, by thus giving correction to all guns, the probabilities are that he is correcting an error common to all, such as a wrongly estimated initial correction given to the battery for wind or other causes, or an inaccuracy in the battery line. It is, however, optional with the battery commander to correct all guns or only the gun concerned. For the fall of every succeeding shell the battery commander will give a separate correction (if required) to the gun which fired it, until each gun of the section or battery has got its own correct line, but he should not, except after the first round, give any correction to "all guns." If, however, there is reason to believe that the correction given to "all guns" after the first round was inadequate or excessive, owing to a faulty estimate of the error of the first round, a further correction may be given to "all guns" after the second round, but after that any further corrections should be given separately to each gun.

It is important for the battery commander to be able to measure correctly the amount right or left that a shell has fallen wide of the target, and especially is this the case when the target is a narrow one. The use of field glasses or a telescope fitted with graticules will probably give the more accurate results, but a fairly accurate estimate of the error can be made provided the field of the glasses or telescope is known. Otherwise some artificial means must be employed, such as a prepared deflection scale held at arm's length or the knuckles of the hand for measuring larger angles.

It is not, as a rule, worth while making smaller correc-

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tions in the deflection than 5′, and when once the deflection of a gun has been corrected it should not be hastily re-corrected unless there is a decided preponderance of rounds to one side of the target.

See also Sec. **38** for deflection corrections when observing visually from a flank.

With instrumental observation of fire the line will usually be corrected according to the observations of one of the observers, and, for this reason, one of the observers should always be placed as close to the line of fire as possible. If this entails his being placed some distance to the rear of the battery, as it frequently will, his observations must be corrected to battery range, as explained in Chapter VII.

But if one of the observers cannot be placed close to the line of fire, without making the base too short, it may still be possible to obtain a position to the rear, and close to the line of fire, from which the target can be seen; and it will then often be advisable to arrange for a third observer to observe for line only from that position in preference to relying upon the observations of an observer some distance to a flank.

When neither observer is near the line of fire, and it is impossible or inconvenient to employ a third observer for line, the battery commander must correct the line on the observations of the nearer of his observers, although the latter may be a considerable distance to a flank. This should, however, be an exceptional case, and the necessity for its employment should only arise when it is not possible to place one of the observers near the line of fire, or to place the battery near one of the observers, or carry but observation for line from immediately in rear of the battery.

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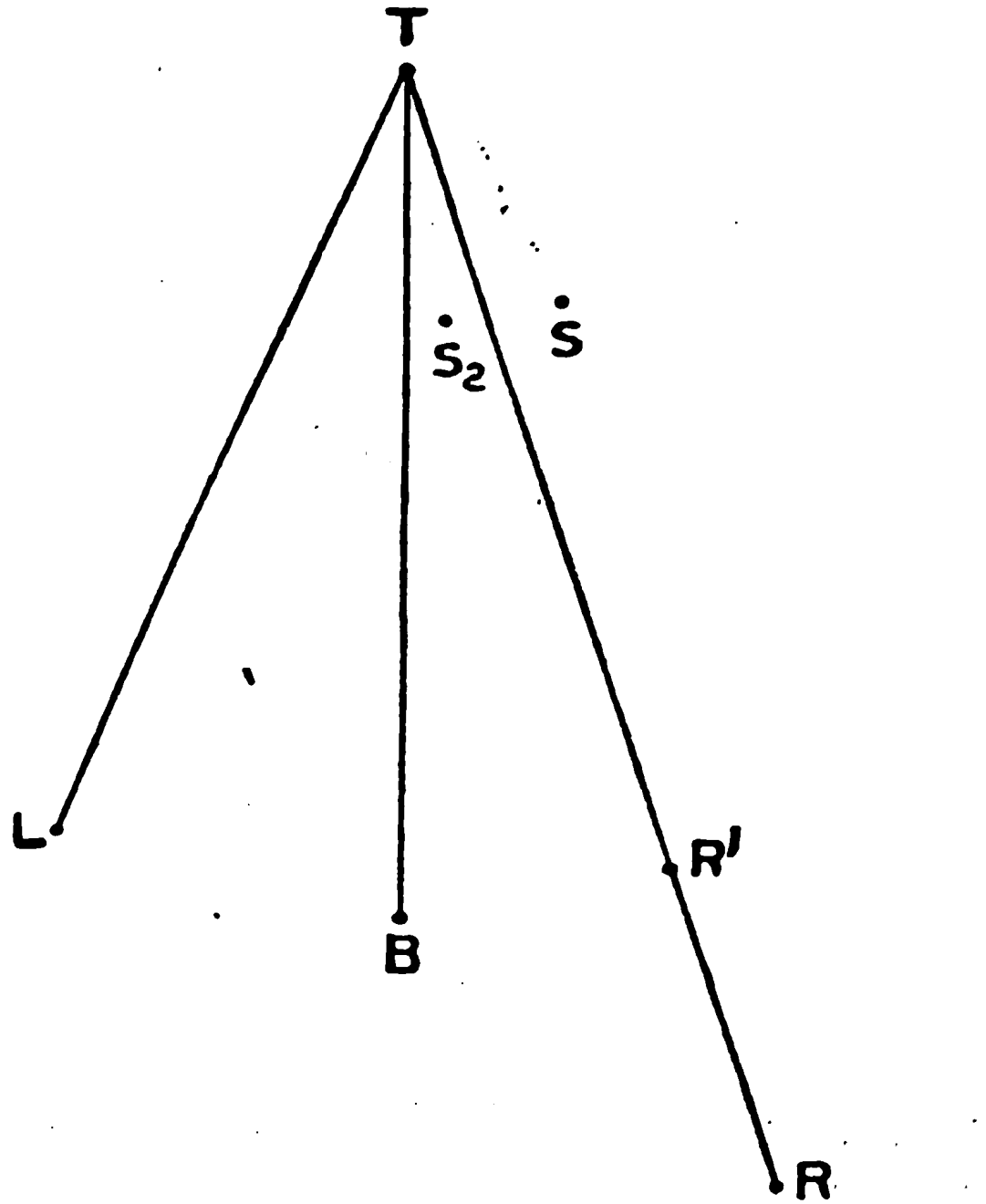
In that case the observations will not be a correct measure of the error of each shell from the battery line.

FIG. 11.



In Fig. 11, R is the right observer, who is the nearer of

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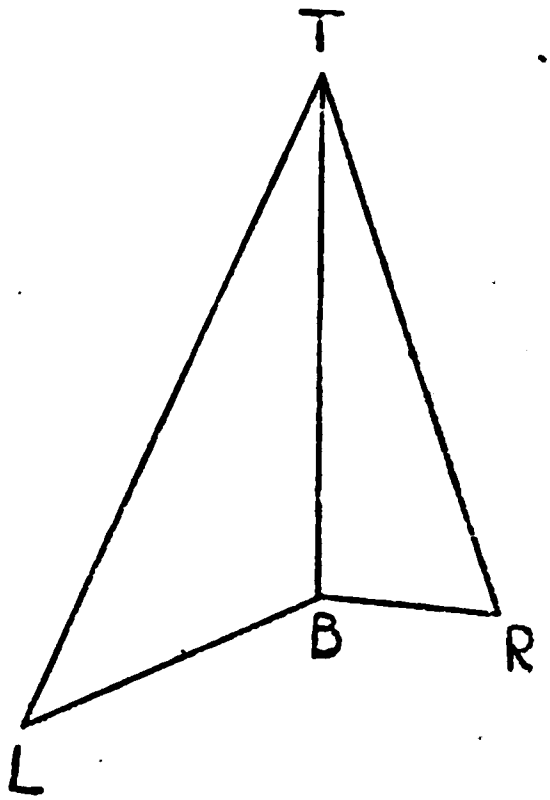
the two to the battery line. His observations will be converted by the plotter to battery range, so that they will be the same as if he were observing from R′. But they will not be accurate observations of the fall of the shell with respect to the battery line. For instance, a shell falling at S, will be observed as so many minutes right

FIG. 12.



of the line RT, but it will be a greater amount right of the battery line. Also, a shell falling at S_2 will be observed as left of the line RT, but it will be right of the battery line. The discrepancy is due to the distance between the lines RT and BT, and therefore becomes less as the shells fall nearer

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to the target ; until a shell falling at T will be observed as "line," and will also of course, be "line" from the battery.

The error, in fact, bears a direct proportion to the amount a shell falls over or short of the target, and a calculation can therefore be made to correct for it. Such a correction, however, is a complication to be avoided, if possible ; and, since by this method of ranging the second or, at any rate, the third round should be approximately "range," it will under ordinary circumstances simplify matters to postpone making any correction for line until then, when the error of the flank observer's observations will be so small as to be negligible for all practical purposes.

Should the first round, however, be *obviously* right or left, a correction for line should be made.

In fact, even when the nearest observer is a considerable distance to a flank, his observations are quite accurate enough throughout without any correction for line, except when the target is a very narrow one.

But when the target is on hilly ground, it is necessary, as previously explained, to correct the line before the range can be found.

In such a case the error of the flank observer's observations may have to be allowed for, if he is far to a flank.

The following is a simple method of doing so :—

In Fig. 12, R is the nearest observer, L is the other observer, B the battery, and T the target.

All that is necessary in order to convert the right observer's observations to battery line is to know approximately the angle subtended at the target by the distance of the right observer from the battery line, that is the angle RTB.

This angle is easily found since the triangle RTB will probably be solved in any case by the field plotter in order

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to obtain the line of fire; the angle RTL is the apex angle which will also have been found.

Suppose R′T is 3,000 yards, and R′B is 250 yards, and the angle TR′B is 119°. The field plotter will give the angle R′BT as 57°, and by adding this to 119° and subtracting the result from 180°, the angle R′TB is found to be 4°. Suppose the apex angle R′TL′ to be 12°, it is seen at once that RB is to RL as 4 is to 12 :—that is as 1 to 3.

This fact having been noted before firing commences the right observer's observations of each round can be corrected to battery line as follows :—

A shell falls at S, and is observed by the right observer as 10′ L, and by the left observer as 50′ R (readings corrected to battery range if necessary). This is to say, that the observation of that shell has changed from 10′ L to 50′ R in passing from R to L, or has changed 60′ R in all between R and L.

Now, since the distance RB is one-third of the whole distance RL, it follows that, from the point of view of B, the observation of the shell will have changed a third of this amount, or 60′ R divided by three, that is 20′ R; so that 20′ R is the correction to apply to the right observer's reading in order to correct it to battery line.

The right observer's reading was 10′ L, and 20′ R combined with this gives 10′ R; which is the corrected reading from B.

The principle is exactly the same if both observers are on the same flank of the battery.

For example, in Fig. 13, suppose RB to RL to be as 1 to 3. Taking the same observations as before, in passing from L to R the observation has changed 60 *Left*, and, therefore, in continuing on to B it will change 20 *more* Left; that is, the correction to apply to the right observer's reading

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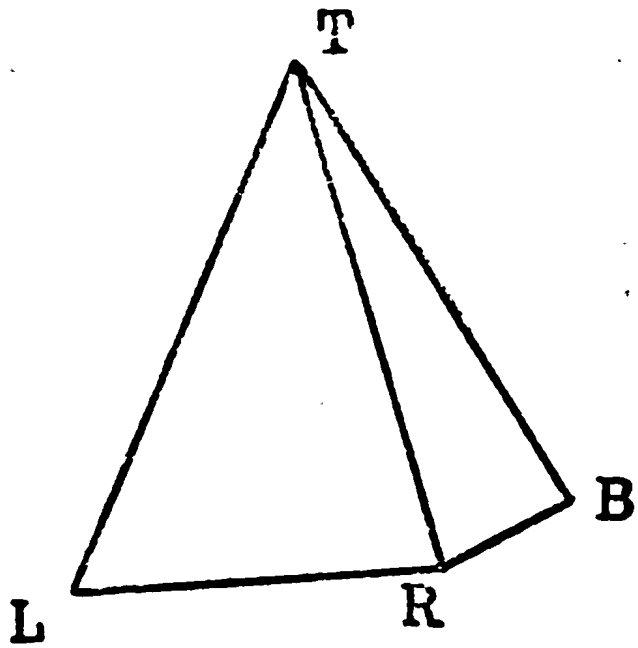
will be 20 *Left*, and the corrected reading will be 30 *Left*.

Whatever the relative positions of the battery and observers, the ratio to be considered is always that of RB (or LB) to RL.

With the aid of a few diagrams and a little practice this method will be easily understood, and once grasped, it will

FIG. 13.



be found that the necessary corrections can be made with very little thought and therefore almost instantaneously.

As mentioned above, however, it is unnecessary, as a rule, to correct the observations in this way except when the nearest observer is some distance to a flank and the target is on hilly ground; and even then all correction of the line observations may cease as soon as the range has been found.

The following are a few more examples of correcting the

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observations by this method (the observers are on opposite flanks of the battery) :—

Ratios of R.B., or L.B., to R.L.	Observations.		Nearest observer.	Correction to apply to nearest observer's reading.	Result corrected to battery line.
	L.O.	R.O.			
$\frac{L.B.}{R.L.} = \frac{1}{4}$	10 R.	50 R.	Left	10 R	20 R.
$\frac{R.B.}{R.L.} = \frac{1}{8}$	45 L.	5 R.	Right	10 L.	5 L.
$\frac{R.B.}{R.L.} = \frac{1}{2}$	30 L.	50 R.	Right	40 L.	10 R.
$\frac{L.B.}{R.L.} = \frac{1}{3}$	15 R.	30 L.	Left	15 L.	Line

When this system is employed the plotter will write in his record the result from column "result corrected to battery line" instead of the "line from line observer," as laid down on p. 81.

39c. *System of ranging on a balloon or kite.*

Fire should be directed so as to obtain the chief effect on the envelope of the balloon or on the flight or lifters in the case of kites.

The range is found with the instruments in the usual manner, but readings should be taken two or three times, and as it is important that these should be taken simultaneously, some arrangement of signals must be made.

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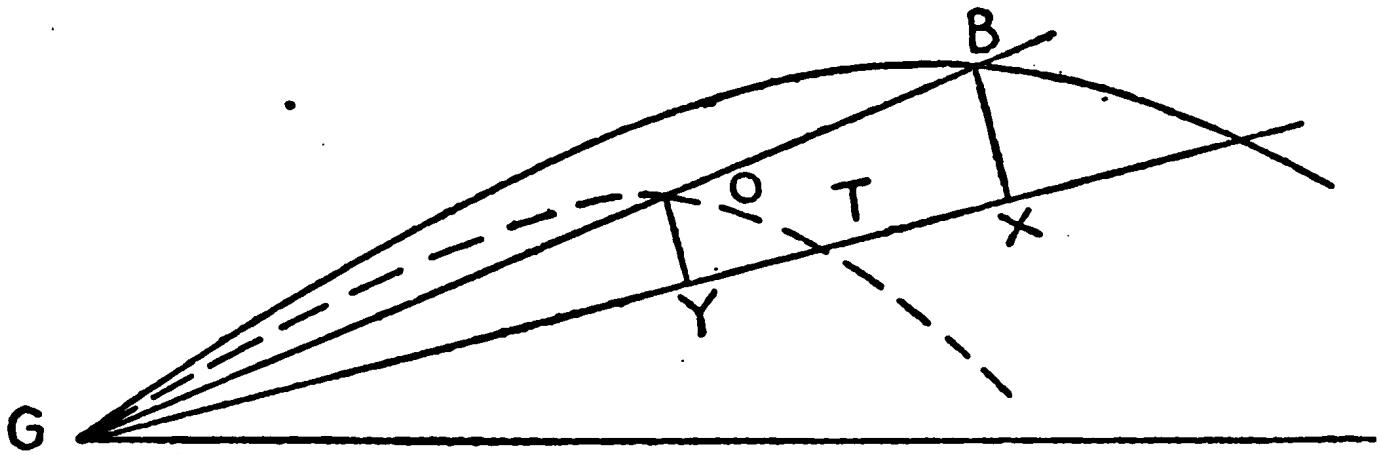
For the purpose of observing fire, three instruments are used, two in the usual manner, while a third with horizontal graticules is employed to find the height of bursts (in minutes) above or below the target.

The procedure will be as follows :—

A round is fired with the elevation and deflection selected as being most likely to bring it near the target. A length of fuze is selected, so as to ensure a burst above the target, but no shorter than is necessary to do so. The position of burst + or − is observed and calculated in the usual manner.

The third observer, who is called the height observer, notes the height of burst (in minutes) above or below the target.

FIG. 14.



In the above diagram (Fig. 14), G is the gun, T the target, B the point of burst.

By combining the right and left observers' results and applying the factor $\frac{5\,R}{n\,A}$, the minutes of gun elevation equivalent to TX are found.

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The height observer gives the angle BGX or the angle at which the shell has burst above the line of sight in minutes.

If the elevation were reduced by the number of minutes recorded by the height observer, the trajectory would pass through X. If the elevation was further reduced by the number of minutes equivalent to TX, the trajectory would pass through T as shown by the dotted line.

A combination of the height observer's results and the right and left observers' plotted results reduced to minutes of gun elevation will therefore give the necessary correction to apply to the elevation.

For correcting the fuze, the battery commander should select a distance short of the target at which it is desired to burst the shell, viz., 75 or 100 yards represented by O in the diagram. In the Range Table he will see the number of minutes of gun elevation corresponding to this; in the diagram represented by the distance YT. 100 yards short is a suitable distance at 3,000 yards range, and 75 yards short at 6,000 yards range.

From the Range Table he will also see what number of minutes of gun elevation correspond to one division of fuze, and construct a scale thereby, so that one division of fuze is equivalent to so many minutes of gun elevation.

The correction necessary is that required to bring the burst back from B to O, or the distance XY, which is the sum of the distances XT and TY.

Both these are known in minutes of gun elevation and by applying the scale of fuze divisions the correction for fuze is determined.

For example:—given the factor $\frac{5\,R}{n\,A} = 2$.

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The distance YT = 100 yards or 30′ gun elevation, found from the Range Table.

1 division of fuze = 40′ gun elevation, also found from the Range Table.

R. and L. observers report 15 R. and 3 L.

Therefore the distance TX = 36′ gun elevation.

Height observer reports burst = + 45′.

The elevation should then be decreased by (36 + 45) or for practical purposes 80′.

The length of fuze should be decreased by (30 + 36) = 66′ or $\frac{66}{40}$ divisions of fuze, say $1\frac{1}{2}$ divisions.

CODE OF ABBREVIATIONS FOR USE IN SIGNALLING.

Aiming point ...	AP.	Common shell ...	CS.
Air	AR.	Concentrate ...	CON.
Air high	ARH.	Lowest charge ...	FIRS.
Air low	ARL.	Next lowest ...	SECD.
All guns	ALL.	„ „ ...	THIR.
Angle	ANG.	„ „ ...	FOR.
Angle of sight ...	AS.	„ „ ...	FIF.
Battery	BY.	„ „ ...	SIX.
Battery fire ...	BYF.	Deflection ...	DFN.
Clamping angle ...	CLA.	Degrees ...	DEG.
Commence firing ...	FIRE.	Director	D.

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Distribute	DIS.	Put flag on director instrument ...	PFD.
Doubtful	QY.	Range	RG.
Echelon	ECH.	Ranging	RGN.
Effective fire ...	EF.	Repeat	REP.
Elevation	EL.	Right observer ...	RO.
Far	F.	Right	RT.
Full charge ...	FC.	Round	RD.
Fuze	FZ.	Seconds	SEC.
Go on	GO.	Section	X.
Graze	GZ.	Section fire	XF.
Gun Fire	GF.	Sub-base	SB.
Left	L.	Put out sub-base ...	PSB.
Left observer ...	LO.	Mark sub-base ...	SBI.
Look out for ...	LOOK.	Switch / Change target ...	CTG.
Line of fire layers	LOF.		
Lyddite	LYD.	Short	MN.
Minutes	MIN.	Stop firing	STOP.
More left	ML.	Target	TG.
More right ...	MRT.	Target flashes ...	FLSH.
No.....gun ...	NO.*	Take flag off director	TFD.
One round ...	ORD.	Time shrapnel ...	TS.
Over or increase ...	PL.	Empty guns / Cease firing ...	MT.
Parallel	PAR.		
Percussion shrapnel	PS.	Unobserved ...	UN.
Probably	PB.		

* Spell Number.

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Example I.

Examples I.—V. to face page 114.

Company
Series
Place
Date
State of Weather and Wind.
Nature of Gun—6″ B.L. Howitzer, Mark I*.
Nature and weight for Shell—Common, 100 lbs.
Charge—Full.
Range—3,000.
Elevation for Range = 10° 39′.
Correction for Angle of Sight = + 20′.
,, ,, Wind =
,, ,, Cordite =
Total Elevation = 10° 59′.

Displacement of :— Deflection for ditto :—
Centre of Battery = yards =
Or of { No. 1 Gun = yards = } By XC.
{ No. 2 Gun = yards = }
{ No. 3 Gun = yards = }
{ No. 4 Gun = yards = }
Deflection for Drift =
,, ,, Wind = 10′ R } = 10′ R.
,, ,, other causes =
Total Deflection for :—
All Guns = 10′ R.
Or for { No. 1 Gun =
{ No. 2 Gun =
{ No. 3 Gun =
{ No. 4 Gun =

5′ alteration of { Elevation = 20 yards.
{ Deflection = 4·36 yards.
50% zones { Length = 19·4 yards = 5′
{ Breadth = 5·2 yards = 6′
Short Bracket = 10′
$\frac{R}{A} = \frac{\quad}{\quad} =$ or $\frac{5.\,R}{A.\,n} =$
Factors for Line (if required) =
Method of Observation of Fire :—Visual.
Battery Commander close to right flank of battery.
Range taken by telemeter, but not very reliable.

Description of Target :—A line of shelter trench with overhead cover running approximately parallel to the front of the battery, and containing no well-defined point on which to clamp observers.

Method of obtaining Line of Fire :—

Director near the Battery.

Battery Angle (if required) =

Battery Commander's Initial Orders :—"Right Ranging, Common."

Deflection :—All Guns 10′ M.R.T.

Elevation :—"11° 30′—10° 0′." "20 seconds." "Fire."

Ranging Point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
7	11 5		Left.	?	No. 4, 20′ MRT.
11	,,			+	
15	,,			+	
19	,,			−	
23	,,			+	No. 4, 11° 0′.
27	11 0			−	
31	,,			−	
35	,,			+	
39	,,			+	
	11 0				

Ranging Point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
6	11 5			−	
10	,,			+	
14	,,			−	
18	,,			−	No. 3, 11° 10′
22	11 10			−	
26	,,			+	
30	,,			−	
34	,,			−	No. 3, 11° 15′
38	11 15			+	

Ranging Point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
2	10 0			−	11° 0′—10° 30′
5	11 10			+	11° 5′, ORD. BYF., 5 Sec.
9	11 5			−	BYF., 15 Sec.
13	,,			+	
17	,,			−	
21	,,			−	No. 2, 11° 10′
25	11 10			+	
29	,,			−	
33	,,			+	
37	,,			−	
	11 10				

Ranging Point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
1	11 30			+	
3	11 0			−	"Stop." 11° 20′—11° 10′. "Go on."
4	11 20			+	
8	11 5			+	
12	,,			−	
16	,,			?	
20	,,			−	
24	,,			+	
28	11 5			Range.	
32	,,			+	
36	,,			−	

* In Minutes of Apex Angle.

Remarks by Battery Commander :—

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Example II.

Company
Series
Place
Date
State of Weather and Wind — Fine. Strong breeze.

Nature of Gun—6″ B.L. Howitzer, Mark I*.
Nature and Weight of Shell—Common, H.E. 100 lbs.
Charge—Full.
Range—4,600.
Elevation for Range = 18° 7′
Correction for Angle of Sight = − 25′
,, ,, Wind = + 10′
,, ,, Cordite = Nil.
Total Elevation = 17° 52′

Displacement of :— Deflection for ditto :—
Centre of Battery = yards =
Or of No. 1 Gun = yards =
No. 2 Gun = yards = } By XC.
No. 3 Gun = yards =
No. 4 Gun = yards =
Deflection for Drift =
,, ,, Wind = 10′ R } =
,, ,, other causes =
Total Deflection for :—
All guns = = 10 RT.
Or for No. 1 Gun =
No. 2 Gun =
No. 3 Gun =
No. 4 Gun =

5′ alteration of { Elevation = 16 yards. Deflection = 6·69 yards.
50% zones { Length = 31·3 yards = 10′. Breadth = 9·3 yards = 7′.
Short Bracket = 20′.

$\frac{R}{A}=\frac{4600}{766}=6$ or $\frac{5.R}{A.n}=1{\cdot}87$.

Factors for Line (if required) =

Method of Observation of Fire :—
Instrumental.
Observers clamped on second gun from right of target,
One observer near the battery.

Description of Target :—
A battery of four guns, subtending about 35′.
Flat country.

Method of obtaining Line of Fire :—
Switch angle from known point on which guns were laid.
Measured by observer near battery.

Battery Angle (if required) =

Battery Commander's Initial Orders :—"All guns ranging Lyddite."

Deflection :—All guns 10′ M.R.T.

Elevation :—18° . Fire.

Ranging Point :—23′ L.

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or− * A. or G.	Consequent orders by the Battery Commander.
	° ′				
4	18 20		37 L	+3	No. 4, 15′ MRT.
8	18 20		31 L	−2	No. 4, 10′ MRT.
12	18 20		20 L	+1	
16	18 20		23 L	−1	
20	18 20		22 L	−5	
24	18 20		24 L	+2	

Ranging point :—11′ L.

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or− * A. or G.	Consequent Orders by the Battery Commander.
	° ′				
3	18 20		20 L	−3	No. 3, 10′ MRT,(1) ORD BY F 30″
7	18 20		10 L	+4	
11	18 20		18 L	+2	
15	18 20		15 L	+4	No. 3, 18° 10′.
19	18 10		7 L	+1	
23	18 10		17 L	−4	

(1) This round is well within the 50 per cent. zone and the result is consistent with those given by Rounds 1 and 2, so the Battery Commander fires a verifying series throughout the Battery at this elevation. A slow rate of battery fire is ordered so that the B.C. can stop the next gun on the observation of any round.

Ranging point :—Line.

No. of round.	Elevation.	Fuze.	Result. Line.	Result. +or− * A. or G.	Consequent orders by the Battery Commander.
	° ′				
2	18 40		3 R	+11	18° 20′.
6	18 20		8 R	+3	No. 2, (2) 5′ ML, BYF 20″.
10	18 20		1 L	+1	
14	18 20		2 R	−3	
18	18 20		3 L	−1	
22	18 20		3 R	+2	

(2) The verifying series through the battery has given the correct proportion of plus and minus rounds, so the Battery Commander proceeds to verify each gun and orders a more rapid rate of battery fire.

Ranging point :—11′ R.

No. of round.	Elevation.	Fuze.	Result. Line.	Result. +or− * A. or G.	Consequent orders by the Battery Commander.
	° ′				
1	18		30 R	−14	All guns, 20′ ML, 18° 40′.
5	18 20		12 R	− 7	
9	18 20		11 R	− 3	
13	18 20		10 R	− 3	No. 1, 18° 30′.
17	18 30		7 R	+ 2	
21	18 30		14 R	− 2	

* In minutes of Apex Angle.

Remarks by Battery Commanders :—

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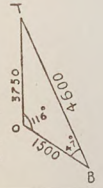
Example III.

Company
Series
Place
Date
State of Weather and Wind— Strong Breeze
Nature of Gun—6″ B.L. Howitzer, Mark I*.
,, and weight of Shell—Shrapnel, 100 lbs.
Charge—Full.
Range—4,600 yards.
Elevation for range = 18° 7′
Correction for Angle of Sight = − 40′
,, ,, Wind =
,, ,, Cordite =
Total Elevation = 17° 27′

Displacement of:— Deflection for ditto:—
Centre of Battery = yards =
Or of No. 1 Gun = yards =
No. 2 Gun = yards =
No. 3 Gun = yards =
No. 4 Gun = yards = } By XC.
Deflection for Drift = 20 RT½ } 20 RT.
,, ,, Wind =
,, ,, Other Causes =
Total Deflection for:— 20 RT.
All Guns =
Or for No. 1 Gun =
No. 2 Gun =
No. 3 Gun =
No. 4 Gun =

5′ alteration of Elevation = yards.
Deflection = yards.
50% zones Length = yards = ′
Breadth = yards = ′
Short Bracket = 30′.
R/A = ——— = or 5. R/A. n =

Factors for Line (if required):—
Method of Observation of Fire:—Visual from a point 1,500 yards to the Left Front of the Battery.
90′ alteration of Elevation = 300 yards range = 1° deflection. Increase of range requires more right deflection.



Description of Target:—
Two unshielded heavy guns oblique to the line of fire, subtending 5′.
Method of obtaining Line of Fire:—
By Angle obtained by field plotter at observing station and sent to director in Battery.
Battery Angle (if required) = 47° RT.
Battery Commander's Initial Orders:—
"No. 1 Ranging, Percussion."
Deflection:—
No. 1, 20′ MRT.
Elevation:—
17° 30′ Fire.

Ranging Point:—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
10	18 45	31	Line	AR 15′	
14	18 45	31	Line	AR 20′	
18	18 45	31	Line	GZ−	

* In minutes of Apex Angle.

Ranging Point:—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
9	18 45	31	Line	AR 20′	FZ 31, ORD BYF.(3)
13	18 45	31	5 R	AR 30′	BYF 15″.
17	18 45	31	10 R	AR 15′	No. 3, 10 ML.

(3) Although he did not get a graze in the echelon, the B.C. selects Fuze 31 because it burst at about the correct height and was corroborated by the first two rounds of the echelon.

Ranging Point:—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
8	18 45	30½	Line	ARH	
12	18 45	31	5 L	GZ −	
16	18 45	31	5 L	AR 20′	

Ranging Point:—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
1	17 30		10 L	?	No. 1, 20 MRT REP.(1)
2	17 30		5 R	−	No. 1, 1° MRT 19°.
3	19 0		10 R	+	No. 1, 25 ML 18° 30′.
4	18 30		Line	−	REP.(2)
5	18 30		5 R	−	No. 1, 20 MRT 19° TS.
6	19 0		Line	+	No. 1 10 ML PAR. LI. to No. 1 Con. 15′ on No. 1, ECH 30, PL ½, 18° 45′.
7	18 45	30	Line	ARH	
11	18 45	31	Line	ARH	
15	18 45	31	Line	GZ	

(1) The B.C. wishes to make sure of the next round falling on the windward side of the target.
(2) The B.C. having to verify both ends of the short bracket he has obtained, commences to do so by repeating the elevation just fired, thereby saving time.

Remarks by Battery Commander:—

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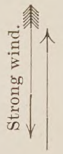
Example IV.

Company
Series
Place :—1,500 feet above sea level.
Date
State of Weather and Wind.
Nature of Gun :—6″ B.L. Howitzer Mark I*.
,, and weight of Shell :—Shrapnel, 100 lbs.
Charge :—Full.
Range :—4,500 yards.

Elevation for range	=	17° 36′
Correction for Angle of Sight	= −	1° 30′
,, ,, Wind	= +	1°
,, ,, Cordite	=	
Total Elevation	=	17° 6′



Displacement of :—		Deflection for Ditto :—
Centre of Battery	=	yards=
Or of No. 1 Gun	=	yards= } By XC.
Or of No. 2 Gun	=	yards= } By XC.
Or of No. 3 Gun	=	yards= } By XC.
Or of No. 4 Gun	=	yards= } By XC.
Deflection for Drift	=	}
,, ,, Wind	=	} =Nil.
,, ,, Other Causes	=	}
Total Deflection for :—		
All Guns	=	Nil.
Or for No. 1 Gun	=	
Or for No. 2 Gun	=	
Or for No. 3 Gun	=	
Or for No. 4 Gun	=	

5′ alteration of { Elevation = 17 yards. / Deflection = yards.

50°/₀ zones { Length = yards = ′ / Breadth = yards = ′

Short Bracket = 30

$$\frac{R}{A} = \frac{\quad}{\quad} = \qquad \text{or} \quad \frac{5.R}{A.n} =$$

Factors for Line (if required) =

Method for Observation of Fire :—Visual, by B.C. stationed about 200 yards behind the battery.

Description of Target :—Infantry and machine guns behind parapet of a strong field work, subtending about 2½°.

Observation of rounds short of the target difficult.

Method of obtaining Line of Fire :—BC's director to XC's director, and "Aiming Point" for "All guns." Parallel lines laid out on right of target.

Battery Angle (if required) =

Battery Commander's Initial Orders :—"Right Ranging, Percussion."

Deflection :—Concentrate 15′ on No. 1 Gun.

Elevation :—18°—16° 30′ (1) "30 Sec." "Fire."

Ranging point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
	16 45			+	LX 16° 45′—16° 15′
	16 15			−	LX FZ, 27½, 16° 30′ XF 30 Sec.
	16 30	27½		AR10′+	
	16 30	27½		AR 15′	LX, FZ 27½
	16 30	27½		G Z−	
	16 30	27½		AR 25′	

* In Minutes of Apex Angle.

Ranging point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
8	16 15	27½		AR 5′	LX, 20′ ML, No. 2, 45′ ML (4), 2 RDs PS 16° 15′, 30 Sec., RTX, FZ 27, XF 30 Sec.
	16 15			−	No. 4, 16° 45′
	16 45			+	
	16 30	27½		AR 30′	No. 3, 30′ MRT.
	16 30	27½		AR 5′−	
	16 30	27½		AR 20′	
	16 30	27½		AR 30′	

(4) Range and Fuze having been found for the Right Section, the BC orders XF and proceeds to range on the left edge of target. He orders 16° 15′ as he does not know whether the range is longer or shorter than the range to the right edge.

Ranging point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
2	16 30			+	16°—14° 30′
5	16 0			−	ECH 26, PL ¾, 16° 15′
7	16 15	26¾		GZ−	(3)
	16 15	27		AR 20′	
	16 15	27		AR 5′−	
	16 15	27		AR 10′	
	16 15	26¾		AR 30′	
	16 15	26¾		AR 20′	

Ranging point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
1	18 0			+	
3	16 0			−	(2) Stop. 16° 30′—16° GO TS
4	16 30			+	
6	16 15	26		AR 60′	
	16 15	27		AR 10′	
	16 15	27		AR 25′	
	16 15	27		GZ+	RTX FZ 26¾
	16 15	27		AR 5′	
	16 15	26¾		AR 25′	

(1) Battery Commander is influenced in the selection of his first pair of Elevations by the ground in the vicinity of the target.

(2) The short bracket having been now obtained, it is un necessary to fire 14° 30′.

(3) As this burst is not corroborated by Rounds 6 or 8, the BC treats it as abnormal.

Remarks by Battery Commander :—

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Example V.

Company
Series
Place—1,500 feet above sea level.
Date
State of Weather and Wind—Strong Breeze.
Nature of Gun—6″ B.L. Howitzer, Mark I*.
Nature and Weight of Shell—Shrapnel, 100 lbs.
Charge—Full.
Range—6,000 yards.

Elevation for Range	=	26° 50′
Correction for Angle of Sight	= −	1° 00′
,, ,, Wind	= +	10′
,, ,, Cordite	=	
Total Elevation	=	26° 00′

Displacement of :—		Deflection for ditto :—	
Centre of Battery	=	yards =	
Or of No. 1 Gun	=	yards =	By XC.
Or of No. 2 Gun	=	yards =	By XC.
Or of No. 3 Gun	=	yards =	By XC.
Or of No. 4 Gun	=	yards =	By XC.
Deflection for Drift	=		
,, ,, Wind	= 15′ RT		= 15′ RT.
,, ,, Other Causes	=		= 15′ RT.
Total Deflection for :—			
All Guns	=		
Or for No. 1 Gun	=		
Or for No. 2 Gun	=		
Or for No. 3 Gun	=		
Or for No. 4 Gun	=		

5′ alteration of { Elevation = 10 yards. / Deflection = yards.

50°/₀ zones { Length = yards = / Breadth = yards =

Short bracket = 40′.

$\frac{R}{A} = \frac{\quad}{\quad} =$ or $\frac{5.\ R}{A.\ n} =$

Factors for Line (if required) =

Method of Observation of Fire :—
Visual by Battery Commander on right of battery.

Description of Target :—
Infantry behind parapet, subtending about 1°, and apparently at right angles to the line of fire.

Method of obtaining Line of Fire :—
Battery Commander's Aiming Posts and Aiming Point for all guns.

Battery Angle (if required) =

Battery Commander's Initial Orders :—" Right Ranging, Percussion."

Deflection :—All Guns. 15′ MRT.

Elevation :—27°—25°. 40 sec. " Fire."

Ranging Point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
10	25 20	37		AR 20′	No. 4. 20′ MRT.
14	25 20	37		AR 20′	
18	25 20	37		AR 20′	

Ranging Point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
9	25 20	38		GZ +	FZ. 37 ORD. BYF. 5 Sec.
13	25 20	37		AR 5′	BYF. 15 Sec.
17	25 20	37		AR 30′	

Ranging Point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
2	25 0			−	26° 20′—25° 40′.
4	25 40			+	25° 40′—25° 0′, TS.
6	25 0			−	ECH. 36. PL. 1. 25° 20′.
8	25 20	37		AR 30′	
12	25 20	37		AR 20′	No. 2. 20′ ML.
16	25 20	37		AR 20′	

Ranging Point :—

No. of Round.	Elevation.	Fuze.	Result. Line.	Result. +or−* A. or G.	Consequent orders by the Battery Commander.
	° ′				
1	27 0			+	
3	26 20			+	
5	25 40			+	
7	25 20	36		ARH	
11	25 20	37		AR 10′	
15	25 20	37		GZ	

* In Minutes of Apex Angle

Remarks by Battery Commander :—

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CHAPTER VII.

Transport of Ordnance and Construction of Batteries.

40. *Methods of transport of siege ordnance.*

1. Medium siege howitzers are usually provided with their own teams of horses on mobilization, and the gun, carriage and limber together form one vehicle. In the case of a regular siege, however, some batteries of medium howitzers may not be horsed, and will therefore depend upon whatever means of transport is available.

2. Heavy siege howitzers will generally have to be transported in pieces by railway, or siege tramway; each part weighs about 5 tons.

3. 60-pr. or 4·7-inch guns are intended for horse, bullock, or mechanical draught.

4. The 6-inch gun on travelling carriage is adapted for animal draught or mechanical traction, but will probably be often transported by rail.

5. Siege ordnance may be transported on land by any of the following means:—

(*a*) Man power.
(*b*) Horse or other animal draught.
(*c*) Traction engine.
(*d*) Railways.
(*e*) Siege tramways.

or, when such exist, by means of canals or rivers.

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6. Vehicles of an aggregate weight of 5 tons can be dragged over good ground by 60 men without difficulty.

It is difficult to use wheel purchases with satisfactory effect at night or with a long rope on which many men are pulling. A wheel must never be manned at the same time that a wheel purchase is being used. When a howitzer has to be dragged some distance, and a long steady pull is required, man-harness should be applied to the rope.

Siege ordnance can be moved up and down very steep inclines by the application of tackles and simple holdfasts.

7. Horses should be harnessed as many abreast as possible. The nearer they are to the weight the better use they make of their power. On fair roads good carthorses will probably pull at least twice the load that the horses ordinarily used for military purposes will. Should the ground, however, be so bad that a carthorse experiences difficulty in moving his own weight through it, he will not pull a greater load than a lighter well-bred horse. In difficult places drag-ropes should be hooked in and man power applied to help, especially after a halt. In such cases the men should begin to pull immediately before the horses are started.

It may sometimes be useful to hook in one or two pairs of horses to each drag-washer, by means of a long trace and a swingletree.

8. Bad ground can be avoided to a considerable extent by good ground scouting ; and a good test as to whether a gun can pass over soft ground is for a man to walk in front of the gun team with a stout stick. If he can press the stick down a couple of feet or more into the ground, it is not safe to take the gun over it ; if he cannot, it generally is, unless the bad ground extends a considerable distance.

In some countries bullock draught may be more suitable, and may often be the only form of transport available.

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9. Traction engines vary considerably in their power. The following tractors are those most likely to be available.

Steam tractors or tractors with internal combustion engines, weighing in working order about 7 tons. Normal load behind the engine 8 tons, *i.e.*, one wagon weighing 2 to 3 tons and carrying 5 tons, or 3 loaded G.S. wagons. These loads they will drag over moderate roads at about 4 miles an hour. Over good roads on the level they could on an emergency work up to twice this rate.

10. On wet or greasy ground, and on slopes steeper than about 1 in 12, the employment of traction engines is unsuitable, as under these conditions they can only move themselves with difficulty. Should such ground, or such a slope, be encountered it can generally be surmounted by taking the engine alone over it first, and then hauling the guns by means of the winding-in gear and the hawser provided. Should the bad ground or slope be long, the ascent must be accomplished in successive portions, according to the length of hawser available.

11. In forming a train of vehicles which differ in weight, the heavier weights should be nearest the engine.

12. When engine traction is employed the shafts or poles are removed, and the engine attachment substituted.

In the absence of an engine attachment, or in the case of vehicles not fitted for it, drag-ropes must be employed instead; it is best to make them fast from trail to trail, passing them underneath the intervening limber. Off shafts are removed, and the near shafts or poles supported by being lashed loosely to the muzzle of the gun in front; care being taken that the lashing is loose enough to avoid any possibility of the shaft or pole being broken in turning corners.

Four-wheeled carriages should be lashed from the ends of the splinter bar to a central point in the carriage in front.

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13. A sufficient number of men should always accompany a train to place drag-shoes, repair breakages, and hold on to drag-ropes when going down slight inclines ; and, if possible this party should be of sufficient strength to unlimber and man-handle the guns a short distance, in the event of its becoming necessary to do so.

14. Railway trucks are of two descriptions : open trucks (where end loading can be employed) and trucks with fixed ends (which must be loaded from the side). If sheers or derricks are used for loading it is immaterial which form of truck is employed ; but when ramps are used, trucks for end loading are preferable, as the operation is more quickly performed.

15. In using railway trucks the following points must be attended to :—

The trucks should not be overloaded, and the weight must be distributed.

The centre of gravity of the load must not be too high, and should be over the centre of the truck.

The height of the load must be such that it can pass under bridges.

Nothing should project to the front or rear in such a way that it will interfere with the trains going round sharp curves.

The load must be securely lashed to the trucks.

16. Siege tramways are laid by a working party under the superintendence of the Engineers. To make the most of siege tramways a thoroughly methodical system of working must be enforced to prevent blocks, useless detention of rolling stock, &c. Suitable regulations should be drawn up and issued. Empty rolling stock should on no account be left at the batteries, but should be returned to where it is

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required. Trouble will be saved if the trollies are loaded in the arsenal and depôts with a view to the most easy and convenient disposal of the stores when unloaded at the other end. The rails should be so laid that those leading to each battery will constitute a siding; the traffic on the main line will not then be interfered with while the stores for a particular battery are being unloaded. (*See also* Military Engineering, Part VI.)

Transport of ammunition.

17. Where no direct railway or water communication with the base of operations is available, and where the roads are practicable, ammunition will be transported in G.S. wagons.

18. In loading these wagons with siege stores the following general rules will be followed:—

(*a*) Each wagon will, as far as possible, only contain one class of store as its main load.

(*b*) If the load consists of a number of heavy boxes, it should be adjusted in the bottom of the wagon in such a manner that the boxes shall have the least possible play. This can generally be done by placing some soft substance between the boxes and sides, or by screwing wooden battens on the bottom of the wagon.

(*c*) Whenever the load consists of loose articles which come above the sides of the wagon (20 inches), care should be taken to properly secure by lashing.

(*d*) The weight of the load should not exceed 30 cwt.

In the case of mobile batteries the ammunition will be carried in G.S. wagons; in this case the load is not to exceed 3,000 lbs.

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In each of these wagons 25 complete rounds of 6-inch howitzer ammunition will be carried.

NOTE.—All siege artillery cartridges are packed in whole metal-lined cases, each of which measures $17\frac{3}{4}'' \times 17'' \times 21\frac{1}{4}''$.

41. *Embarkation and disembarkation.*

1. The operation of embarking and disembarking the siege artillery will be controlled by the Royal Navy, who will provide the boats, lighters, and any labour required in connection with the same. Any additional labour that may be needed will be found by the Army (*see* "Field Service Regulations, Part II, App. V").

2. It may be necessary in disembarking or unloading siege pieces to erect sheers and derricks, the method of erecting which and the stores required will be found in Garrison Artillery Training, Vol. III. Light siege sheers will raise weights up to 90 cwt., and will usually be found sufficient for all requirements.

3. When jetties of a semi-permanent or temporary nature are required, they will be constructed under the superintendence of the Royal Engineers.

42. *To load a howitzer on to a barge.*

1. Should navigable rivers or canals be available, it may be advisable to employ them for the transport of siege ordnance, if suitable barges can be obtained. The method of embarking and disembarking will depend upon the facilities which exist.

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In the absence of any facilities, a swinging derrick will in most cases be suitable; or, if the nature of bank and depth of water admit of the barge being brought close to the gun, and about on the same level, it may be possible to use a gangway constructed of railway irons and sleepers in a similar manner to the ramp described in Section 43.

2. In the case of tidal waters barges may be plentiful, and may be made use of. They should be brought as near shore as possible at high tide, and allowed to ground. Flat bottomed barges are preferable; but if only barges with keels are available, care will be required to keep them vertical when they take the mud.

As soon as the barge is clear of the water, guns can be embarked or disembarked by means of long skids or similar baulks.

3. It is an advantage if the barges are plentifully provided with eyebolts or bollards for lashing to holdfasts, in order to retain them upright, and for lashing the skids. The ends of the skids should be supported as near the centre line of the barge as possible, not on the gunwale; and the guns should be stowed so as to trim the barge. If the distance from the barge to the nearest point to which the gun can be brought is considerable, or the slope steep, it will be necessary to arrange the skids in bays, with a succession of supports. In that case the bay nearest the barge should be as nearly as possible horizontal, and easily removable; the remainder being more or less permanent, and practically constituting a small wharf or jetty. Guns can be run over the skids limbered up, if the distance apart of the skids is carefully adjusted, and they are firmly secured; but the operation is easier if the skids are covered with a cross layer of sleepers.

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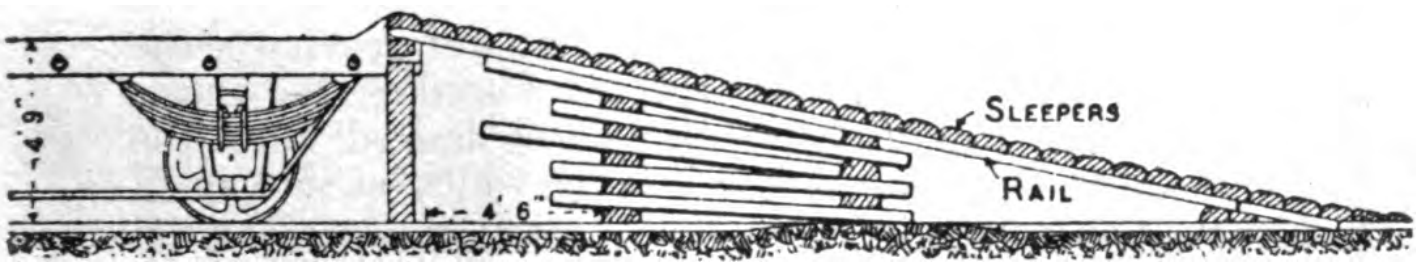
43. *To load a howitzer on to a railway truck by means of a ramp.*

A simple and quickly constructed form of ramp is shown in Fig. 15.

FIG. 15.



The stores required are 4 rails and about 50 sleepers.

The rails can rest either as shown on a sleeper across the buffers with the buffers supported, or on the end of the carriage. It is better, however, to support the top of the ramp independently of the truck, so that trucks may be run up to the ramp, and away again when loaded, without interfering with the ramp. When a ramp is employed for side loading it is essential that it should be so constructed, in order to admit of trucks being run past it in succession.

44. *To load and unload a howitzer on to and from a trolley.*

1. *To Load.*—The howitzer, limbered up, is placed with its wheels on either side of the rails, so that the axis of the howitzer and centre of the limber are in the same vertical plane as a line midway between the rails, the muzzle being towards the trolley. Two inclined planes made for the purpose (planks and scotches can be used), one for each wheel, are then placed in rear of the howitzer wheels just so far apart that the trolley will run between them, and the

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howitzer hauled up the inclines until the trolley can be run under the axletree bed and trail. Howitzers should be in their firing position, as no difficulty is then experienced in shifting the trail. Should the trail have a tendency to fly up it must be lashed down. When the wheels are scotched up and pieces of skidding have been arranged on the trolley to receive the axletree bed, the howitzer is unlimbered, the centre of the trolley is run under the centre of gravity of the howitzer and carriage, and the trail is lowered. The wheels are then unscotched and the trolley is moved until the howitzer takes a bearing on the skids, which should be of such a height that hooks and other projections on the axletree bed cannot foul the trolley, and that the howitzer wheels should be about 6″ clear of the ground. It is difficult to load or unload a trolley on a curve ; a straight piece of railway should be chosen for the purpose.

2. *To Unload.*—The ramps are placed under the wheels and touching them. The howitzer is hauled up by means of a wheel purchase till clear of the trolley and scotched up ; the trail is lifted, by 6 men, on a lever passed across, care being taken that it is not lifted too high. The trolley is run to the rear and the trail allowed to rest on it. The wheel purchases are manned, the scotches removed from the ramps and the howitzer allowed to run down.

45. *Construction of batteries.*

1. The penetration of howitzer shells is so great and their effect so powerful that very substantial overhead cover is required to resist them. This requires much time, labour, and material, consequently security must depend almost entirely on concealment, which should be obtained as far as possible by utilizing natural features of the ground or, in their absence, by artificially screening guns from view.

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Measures should, however, be taken to provide such cover as will, at any rate, localize the effect of shells, give protection from shrapnel fire, and serve to enable the detachments to defend themselves with rifle fire if attacked.

Great care must be taken that screens, whether natural or artificial, do not intercept the trajectory when firing high explosive shell.

2. The great use to which balloons, kites, &c., are now put in order to locate the position of opposing batteries, has rendered the concealment of the latter much more difficult than formerly. Guns and howitzers have to be placed sufficiently far behind woods and other high cover to enable the trajectory of the shells to clear them, and this exposes them to the view of balloons at practicable heights and ranges.

3. The actual design of the parapets and traverses will vary somewhat according to the nature of the ground and the amount of natural cover obtainable, and it is undesirable to lay down any particular type for universal adoption.

The best form of cover is that obtained by digging deeply down, so that the muzzles of the howitzers, when elevated for firing, are flush with the natural level of the ground, the men also being hidden in underground bomb-proofs. No parapets or traverses should be thrown up, as these catch the eye, even from a great distance and give away the position.

4. As time permits, shelter from weather should be provided for the detachments, and if possible overhead cover from shrapnel bullets. If this latter is not provided, the trench should be deep and the inside of the front parapet steeply revetted, as this will provide cover from all but very high-angle shrapnel.

5. The essential point to be kept in view is that efficient

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splinter-proof protection for the gun detachments must be provided in front and on both flanks, and, if circumstances admit of it, also in rear, provided arrangements are made for withdrawing the guns if necessary, and the protection does not interfere with the view to auxiliary marks, &c.

6. Siege batteries should be protected by wire entanglements and other obstacles from possibility of capture by surprise.

7. Whenever possible, alternative positions (and easy communication to them) should be prepared; so that, should the battery become untenable, the guns can be moved quickly to a fresh position.

For methods of constructing cover, *see* "Manual of Field Engineering."

8. The batteries should be numbered from right to left in each section of the attack, and the numbering will be continued in sequence with any other batteries which may be subsequently constructed. Boards with the number and armament clearly marked or painted on them should be conspicuously posted up on each flank near the magazine, to guard against mistakes on the part of those charged with the arming of the battery, the supply of ammunition, or with the conduct of reliefs.

9. The observing stations should be lettered R or L (right or left), and numbered to agree with the batteries to which they belong.

46. *Laying double deck platforms.*

1. A convenient detachment to lay the platform is a N.C.O. and 12 gunners, who would in ordinary soil lay a Mark II. platform with holdfast in about 6 hours.

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Stores.

6 picks.	1 grease pot.
6 shovels.	2 spanners, No. 185.
2 rammers, earth.	1 piece chalk.
1 field level or clinometer.	1 McMahon spanner.*
1 6′ measuring rod.	1 broom.
100′ tape.	1 tommy, No. 30.
2 banderols.	1 tommy, No. 31.

2. Before taking the platform up to the battery care should be taken to see that it is complete in all parts. It is advisable when unloading the platform at the battery to lay the planks down in rear in the relative positions in which they would be when the platform is laid. This can be done by half the detachment whilst the ground is being marked out. The platform should be laid horizontal.

Preliminary.

3. The front and rear transoms are laid down in the required positions and temporarily bolted up by means of two planks and bolts, and by means of cross measurements the platform is squared. The ground is then marked by a pickaxe where the transoms and planks rest, and the frame is removed.

4. The slope of the ground is ascertained by placing the front and rear transoms on edge and taking the difference in level between them, using a plank and field level or clinometer for the purpose.

If the ground slopes to the front, the front transom should be laid first. If otherwise the rear transom first. The first

* Or spanner, adjustable, 15-inch.

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laid transom should be sunk till its top surface is flush with the ground ; if it is the rear one (*i.e.*, if the ground slopes to the rear), it is preferable to sink it from 3 to 6 inches more than this.

If, however, the natural cover is slight, or if the surface of the ground is boggy, it will often be advisable to sink the platform considerably lower than this ; the excavated earth being used to form the parapet and side traverses.

5. In all cases the process of laying is identical, bearing in mind that the front and rear transoms must be adjusted so that the top surface of the front one is level with that of the rear one.

Process of laying.

6. Cut the trenches for the front and rear transoms so that they will be level with each other, and also level transversely. Their position should be such as to leave room for the holdfast between the front transom and the front parapet, and also for a trench for the detachment should such a trench be employed. In some cases it may be advisable to construct the trench on a flank, outside the emplacement, and then only room for the holdfast need be left.

(*Note.*—In cutting the trenches for the transoms care should be taken that the rear face is disturbed as little as possible.)

7. Both transoms are sunk the necessary distance apart, and parallel. Two trenches are then cut until two planks on edge bear evenly on the outer ends of both transoms, and if the transoms are correctly laid, these planks will be level. This may be ascertained by placing the field level on each plank in turn, or a clinometer set at zero may be used for the same purpose.

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Care must be taken that the bolt holes in both planks and transoms come opposite each other.

8. The ground in the centre of the platform is then cut away level with the two trenches for the long planks, and the two remaining transoms bedded in flush with the surface. These transoms are placed as already stated, but as the platforms vary somewhat the holes in the planks will give their exact positions. The lower portion of the pivot plate is placed with its centre 3 ft. from the front of the platform, and in the "line of fire," and sunk so that the upper surface is flush with the ground. The planks of the lower layer are placed in position from the centre outwards, the bolts in the pivot plate fitting into the holes in the planks. The upper layer is laid across, commencing at the pivot. The four planks which lie immediately over the transoms have holes in them for 8-in. screws to pass through the two layers of planks and bottom transom.

The top portion of the pivot plate is placed in position and the bolts tightly nutted up, by using the McMahon spanner and finishing up with the knock-up wrench, or spanner No. 181.

9. Unless care is taken in getting the platform laid *square* great difficulty will be found in fixing the pivot plate.

10. These platforms should be very carefully laid, the under layer of planks should be in bearing with the ground throughout; and the less the natural surface of the earth is interfered with the better.

With the Mark II. platform the holdfast can be attached to the front transom at any time, so the work of digging the trench and placing anchorage can proceed without interfering with the laying of the platform.

Great care should be taken that the holdfasts have a firm bearing and that the earth is well rammed round them.

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11. The following are the weights and measurements of the platforms and component parts :—

Store.	Package.	Weight.		
		cwts.	qrs.	lbs.
Platform, siege, double-decked, Mark II	38 loose planks and 1 case of bolts ...	30	0	17
Arm, radial, pivot, D.D. platform, Mark II	1 loose	1	2	14
Holdfast, platform, D.D., Mark II	Case of 1 set ...	2	3	18
Plate, pivot, D.D. platform, Mark II	1 loose	8	0	4
2 plates, wheel, platform, siege (*each* 1 cwt. 2 qrs. 21 lbs.) ...	„	3	1	14
Plank, traversing, B.L. 6-in. howitzer	„	1	3	0
Anchorage buffer	„	1	3	10
Total weight of platform and appurtenances complete ...	...	49	2	21

47. *Magazines.*

1. The main magazine will be adjacent to the advanced ordnance depôt, and will be in charge of an ordnance officer, but a magazine must be formed at each brigade ammunition depôt. The Regulations for Magazines will be carried out as far as circumstances allow.

2. The following are the chief points to be attended to regarding these magazines :—

(*a*) Systematic arrangement.

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This implies that the cartridges for each nature of ordnance should be stored by themselves, and cartridges of different lots of cordite should not be mixed up together.

(*b*) Efficient protection.

i. From fire.
ii. From damp.

i. As regards the first, carefully selected men should be permanently employed. Scrupulous cleanliness in the magazines should be observed, and sufficient isolation from any buildings or tents where fire is used be secured.

The precautions enjoined in the Regulations for Magazines, &c., should be observed.

ii. As regards the second, all metal-lined cases are to be raised off the ground on planks, sleepers, or skids. Hospital tents, being double, afford efficient protection from the weather. Tarpaulins placed over such stores in the open are bad ; everything underneath them becomes covered with dew, or, as it is commonly termed, "sweats."

Stowage of projectiles.

3. The projectiles for each nature of ordnance should be stowed by themselves (each pile being clearly marked) and as much protected from the weather as possible.

48. *Expense magazine.*

1. Cordite is slightly affected by differences of temperature, but is almost unaltered by dampness ; and it is doubtful if any explosion would occur even if it were struck by a shell.

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Consequently the expense magazine will be a weather-proof and possibly splinter-proof protection, but nothing more.

In the construction of such magazines, small timber scantlings, tarpaulins, and corrugated iron are all of great use.

2. The temperature of magazines for cordite should not exceed 100° Fahrenheit, so that corrugated iron covering should not be used without earth over it.

3. The sites of magazines would in most cases be on the flanks of the batteries, not more than 100 yards away from the flank guns, with some splinter-proof connecting trenches between them and the battery.

49. *Expense shell stores.*

In addition to the magazines necessary for the storage of cordite cartridges, other arrangements will have to be made for the storage of shells filled with high explosives. These shells are liable to be detonated, if a shell similarly filled detonates in contact with them; consequently, in order to limit the possible loss of shells, they should be dispersed in small shelters on the flanks of the batteries. These shelters should be designed so that the shells lie on their sides, with a splinter-proof covering of earth thrown up around them to prevent the lateral dispersion of fragments and with splinter-proof overhead cover.

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CHAPTER VIII.

Siege Artillery in War.

50. *General principles of the employment of siege artillery.*

The general principles of the employment of siege artillery in attack and defence are stated in Field Service Regulations, Part I.

A description of the modern permanent land defences, for the attack of which it is a special duty of siege artillery to prepare itself, will be found in Military Engineering, Part II.

51. *The siege artillery commander.*

1. The siege artillery commander is the technical adviser in siege artillery matters of the commander of a besieging force, and commands the whole of the siege artillery engaged.

2. If field artillery is also employed, the whole, or a portion of it, may be temporarily or permanently placed by the commander of the besieging force under the orders of the siege artillery commander.

3. Under the orders of the commander of the besieging force the siege artillery commander selects the general line and area to be occupied by the siege artillery brigades with due regard to the protection which can be afforded by the besieging infantry.

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He keeps the officers commanding sections or zones of attack informed as to his plans, in order that works, clearances &c., carried out by them may not prejudice the siting of siege batteries; otherwise, for instance, in clearing the field of fire for the infantry trenches of the investing line, cover might be removed which would be valuable later to form a screen for guns.

4. The siege artillery commander issues instructions as to the front to be occupied and the tasks to be accomplished by each siege artillery brigade. He also generally superintends and controls the artillery fire in accordance with a well-considered plan, and to this end gives the brigade commanders their special objectives, supplies them, if possible, with maps and plans of the hostile works, and informs them as to the positions occupied by other siege artillery brigades, and by the remainder of the besieging force.

5. He notifies the time for opening fire and the sequence of fire, allots to each siege artillery brigade the number of rounds he considers necessary, and receives daily reports of the expenditure of ammunition and the effect produced by each brigade, together with any information as to hostile movements or changes in objectives which have been observed.

52. *The siege artillery brigade commander.*

1. The superintendence and control of fire is the special duty of the brigade commander, and the results obtained will depend upon :—

(*a*) Judicious selection of observing stations and positions for batteries.

(*b*) Good system of communications.

(*c*) Efficient supply of ammunition.

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2. As soon as the ground to be occupied by the brigade and the task allotted to it has been notified to the brigade commander, he will determine :—

i. His own station.
ii. The stations for the observers.
iii. Sites for batteries.
iv. Stations for battery observers. } In conjunction with battery commanders.
v. Sites for brigade ammunition depôts.
vi. A system of communication.

3. It is most important that each brigade commander should take steps to ascertain at an early stage the exact positions selected by other brigade commanders for their batteries, observing stations, brigade ammunition depôts, &c., so that mutual assistance may be facilitated and clashing or interference avoided.

4. The station of the commander of a siege artillery brigade should be in a commanding position and if possible centrally situated as regards his command.

5. The brigade commander's staff includes one pair of observers, a plotter and two range takers.

The duties of these observers are to search for, discover and record new targets, and to assist the brigade commander in watching and superintending the fire of his batteries on the targets allotted to them.

It will always be advisable to have one of these observers as near to his own station as possible so that an observing instrument may be available for his use if he wishes himself to observe the fire.

6. The brigade commander is responsible that a proper and complete system of communication by telephone or otherwise is arranged and maintained throughout his command.

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53. *Chain of command.*

The chain of artillery command in a siege force, is shown on the following diagram :—

SIEGE ARTILLERY IN THE ATTACK.

54. *General Principles.*

When attacking a fortress the object is to effect its capture at the earliest possible moment.

This will generally speaking be attained either :—

i. By surprise.
ii. By assault.
iii. By bombardment.
iv. By regular siege.

Resort being usually had to the last only when one or more of the others have been tried without success.

55. *Operations preliminary to the siege.*

1. Before siege operations can be commenced the garrison of the place must be driven into the main line of defence.

The area immediately outside this line will then be reconnoitred by staff, engineer, and artillery officers, with a view to the selection of a position suitable for defence, which is called the line of investment, where sorties in force can be resisted, and under cover of which preparations for the regular operations of the siege can be securely made.

2. The establishment of the besiegers in the line of investment marks the conclusion of the first phase of the siege. The commander of the besieging force will now consider proposals as to the locality or localities where the attack is to be pushed home, which will be drawn up by the General Staff, after consultation with the commanders of the siege

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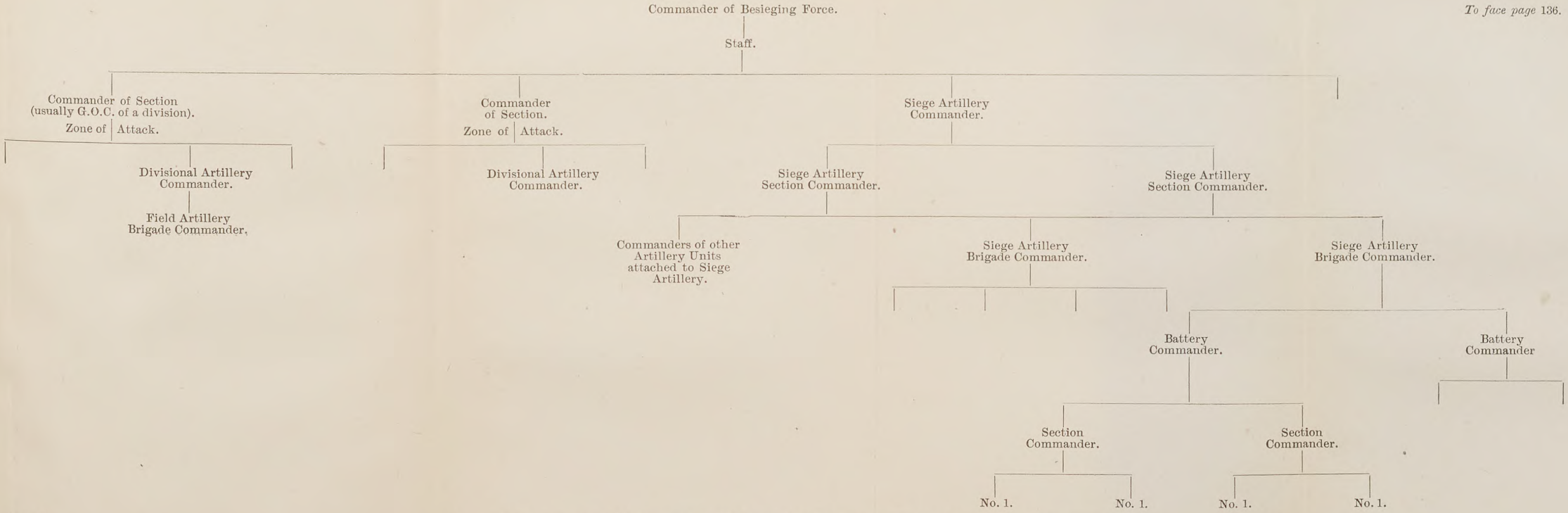

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NOTE.—The Commanders of Sections command all troops in their Sections with the exception of the Siege Artillery.

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artillery and of the engineers. This locality is known as the "*Front of Attack*," while the ground over which the attack is made is called the "*Zone of Attack*."

3. Meanwhile the line of investment will have been divided into sections numbered from right to left from any suitable point, and a sufficient force allotted to each section.

4. The troops detailed to operate against the "*Front of Attack*" may, if necessary, be subdivided into "right," "centre" and "left" attacks; or, if two subdivisions only are required, into "right" and "left" attacks.

5. The general line and positions to be occupied by the siege artillery commander, the infantry of the investing force being so disposed as to secure the safety of guns.

56. *Function of the siege artillery.*

1. The rôle of siege artillery is to break down the moral of the defenders by destroying their fortifications and war material, and so to prepare the way for the assault. When this moment arrives, the heaviest fire that can be brought to bear will be concentrated on the enemy's personnel, and on any guns remaining in action, with the double object of weakening the fire of the defenders on the attacking columns and of inflicting loss at the critical moment of the struggle.

2. The divisional artillery of the besieging army will be similarly employed under the orders of the divisional commanders, arrangements for co-operation with the siege artillery for special objects being made, as required, by the officer commanding the siege force.

57. *Silencing of the enemy's guns.*

1. Guns mounted in armoured defences or in concrete or other casemates, may be dealt with by either gun or

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howitzer fire. As a general rule, if such defences are visible, they should be attacked by the heaviest guns, otherwise the heaviest howitzers should be employed.

2. Guns not so protected should, generally speaking, be attacked with shrapnel, even when in concealed positions, the aim being rather to overwhelm the detachments with shrapnel fire than to attempt the difficult task of obtaining direct hits on material or emplacements. If, however, the gun emplacements are blinded, it may be necessary to employ high explosive shell to destroy the blindages.

3. Guns mounted on railway trucks, unless they appear in the open, can best be attacked by howitzer fire. A rapid rate of fire should be maintained, and both shrapnel and high explosive shell used; the latter on the chance of destroying some portion of the line, which will prevent the guns being easily moved to fresh positions.

Destruction and breaching of the enemy's works.

1. The destruction of material is best effected by the action of high explosives, and for this purpose common or high explosive shell will be used in the earlier stages of the attack.

Howitzers, firing high explosive shell of relatively large capacity, at high angles of elevation and consequently with steep angles of descent, are generally best adapted for the destruction of material. Heavy guns may also be used for this purpose, when they cannot be advantageously employed for other purposes.

2. The procedure adopted when attacking material with high explosive shell will depend upon the nature of the target.

In the case of earth parapets, the lower portion of the

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exterior slope should be attacked, the shells being burst sufficiently far down the slope to ensure that the earth above the point of impact will be blown down.

3. The destruction of casemates, magazines or blindages, as a rule, can be attained only after expenditure of a large amount of ammunition. If such works cannot be located from a balloon, kite or airship, they may be attacked by "searching fire," that is by first ranging upon some point known to be in their vicinity, and then systematically altering the elevation and deflection every few rounds. This method should, however, only be attempted when ammunition is plentiful, or when it is held that the ends to be attained are sufficiently important to justify the expenditure of a large quantity of ammunition.

4. When breaching the escarps of permanent works the object is to form a ramp which will be practicable for the assaulting column. This is attained by breaking away a length of 20 or 30 yards of the upper portion of the wall, which will cause the fall of the portion of parapet above it.

The projectiles should strike the escarp at an angle similar to that made by a line drawn from the crest of the glacis to a point half-way down the escarp, the angle being, if possible, measured from a section drawing of the ditch. The crest of the glacis should be taken as the mean point of impact.

Good results cannot be expected from oblique fire at more than 45 degrees, or with a striking velocity of less than 450 f.s.

With howitzers firing with angles of descent of more than 45°, good effect may, however, be attained by striking the inner edge of the top of the escarp wall, thus tending to burst the wall outwards.

5. To breach a detached wall standing near the counter-

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scarp projectiles must be fired at such an angle as to strike the wall about three feet above the ground.

6. It will rarely be possible to declare that breaches are practicable until the advanced works of the attack have approached the glacis, and close reconnaissance has been carried out from them.

7. To render the interior of permanent works untenable, fire must be directed at an angle of elevation calculated to give an angle of descent that will clear the covering parapet. For the destruction of bombproofs, bombardment from howitzers with high explosive shell promises the best results until the cover has been broken down ; after which shrapnel fire against the personnel should be employed, and in addition, when it can be brought to bear, enfilade or reverse fire with shrapnel from long-range guns.

8. The effect of high explosive shell is so local that no "sweeping" effect can be looked for from the bursting of the projectile ; while "searching" effect, which is so often valuable, is not necessarily increased by the oblique direction of the fire. To break down a parapet frontal fire is usually more effective than enfilade, but for other purposes reverse or enfilade fire will usually be more effective, especially when shrapnel is employed.

58. *The support of the assaulting infantry.*

1. The operations of infantry and engineer can best be supported either by a heavy shrapnel fire, both frontal and enfilade, against the defender's firing lines, or by bombarding the permanent works to be attacked, and the gun positions that can support them, with high explosive shell or shrapnel.

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2. Rifle fire can be kept down by a heavy shrapnel fire against the trenches, unless they are well blinded when frontal or enfilade fire with high explosive shells may give better results. Except in such cases, high explosive shell should not be employed against trenches, as only direct hits can be effective and the damage done by them will be small and very local.

59. *Siege ordnance.*

1. It is a maxim that in war every piece that can inflict damage should be brought to bear against the enemy.

2. In siege operations howitzers will, on account of their searching power, mainly be employed, especially against such objectives as the walls of escarps, overhead cover, or troops behind high ground. At the same time, owing to the difficulty of ensuring accurate fire when elevations of 45° and upwards are used, every endeavour should be made to limit fire at such elevations.

3. Guns are mainly of use to bring shrapnel fire against troops in the open and on the move, but may be employed for attacking forts, &c., beyond the range of the howitzers when a considerable angle of descent is not required, or when howitzer fire is unreliable, as it is at long ranges when the wind is strong and gusty.

60. *Choice of projectiles.*

1. The choice of the projectile to be used is determined by the nature of the target to be attacked.

Against most defences a combination of both high explosive and shrapnel fire will be required, the proportion varying according to circumstances.

2. High explosive shell is essentially the projectile of

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bombardment, when moral effect as well as actual results against materials of all kinds, houses, buildings, &c., is desired. It should also be used against shipping, dockyards, and magazines.

3. Shrapnel is the projectile with which personnel should be attacked, whether in the open or behind entrenchments; and as it is the personnel that has to be overcome before the position can be captured, siege pieces may more usefully employ shrapnel than high explosive shell after the defence works have been broken down, and whenever there is a prospect of inflicting considerable loss on the personnel. Shrapnel will also be used to search out the interior of works, and cripple the garrisons prior to and during the infantry assault. The infliction of damage on the defender's entrenchments, when using high explosive shell, is largely a matter of chance, but shrapnel will always compel the enemy to keep under cover, and at the time of the infantry advance and assault this is of vital importance. It should be noted, however, that fire with high explosive shell can be kept up longer than fire with shrapnel without running the risk of injuring the assailants.

61. *Position of batteries.*

1. The siege artillery commander will generally allot a certain area and objectives to each brigade, but the brigade commander will select the actual positions of his batteries in consultation with the Engineer officers immediately concerned, as to the laying of siege tramways, &c.

2. In order that congestion of traffic and friction with the other arms may be avoided, the siege artillery commander will ascertain from the headquarter staff what roads have been allotted for the movement of the various siege artillery

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batteries and will issue the necessary orders to his brigade commanders so that there may be no confusion preparatory to and during the arming of the batteries.

3. Siege pieces are normally, and howitzers invariably, placed in covered positions, which must be selected with the greatest care.

In determining the sites for the batteries, the following points should be borne in mind :—

(*a*) They should be on ground from which an effective fire can be delivered.

(*b*) They should be concealed from the enemy's view, and be so placed that they will be difficult to locate.

(*c*) They should admit of simple fire direction from suitable observing stations, and as far as possible of the lines of fire being laid out by simple means.

(*d*) Means of communication to the rear must be kept in view, and the proximity of roads or ground over which tramways can be laid for conveying ammunition from the advanced ordnance depôt to the batteries. As tram lines will usually be available for the transport of the ammunition, brigade ammunition depôts should not be placed too near the batteries.

(*e*) Gun batteries should be placed towards the flanks of the position, where opportunities will be greater for the employment of enfilade fire. Howitzer batteries are better sited to employ frontal fire.

(*f*) The batteries of a brigade should, as a rule, be kept fairly close together, in order to facilitate

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command. In operations, on a small scale, when only a few siege pieces are employed, it may, however, be advisable to resort to dispersion of batteries and concentration of fire.

(*g*) Facilities for direct laying must be considered, bearing in mind that this should be employed when firing at a moving target, such as that afforded by a counter-attack, at troops landing from boats, at guns which the enemy may run forward into exposed positions, in support of the counter-attack, or on any other occasion to take advantage of some fleeting opportunity.

(*h*) The nature of the subsoil should be taken into consideration. Light dry soil is most suitable for platforms, but the presence of rock or water within 3 feet of the surface will cause considerable difficulty in laying the holdfasts for platforms.

Should there be any difficulty in complying with all these conditions it will be best to satisfy the most important, and not to attempt to fulfil with them all; for it has been found that in practice such procedure leads to inaccuracies and thus defeats its own ends. The subject is more fully discussed in Chapter V.

62. *Chain of communication.*

1. The chain of communication between the siege artillery commander and his brigade commanders, between each brigade commander and his batteries, and between the brigade and battery commanders and their respective observers, is shown on the accompanying diagram.

There is also communication between each brigade com-

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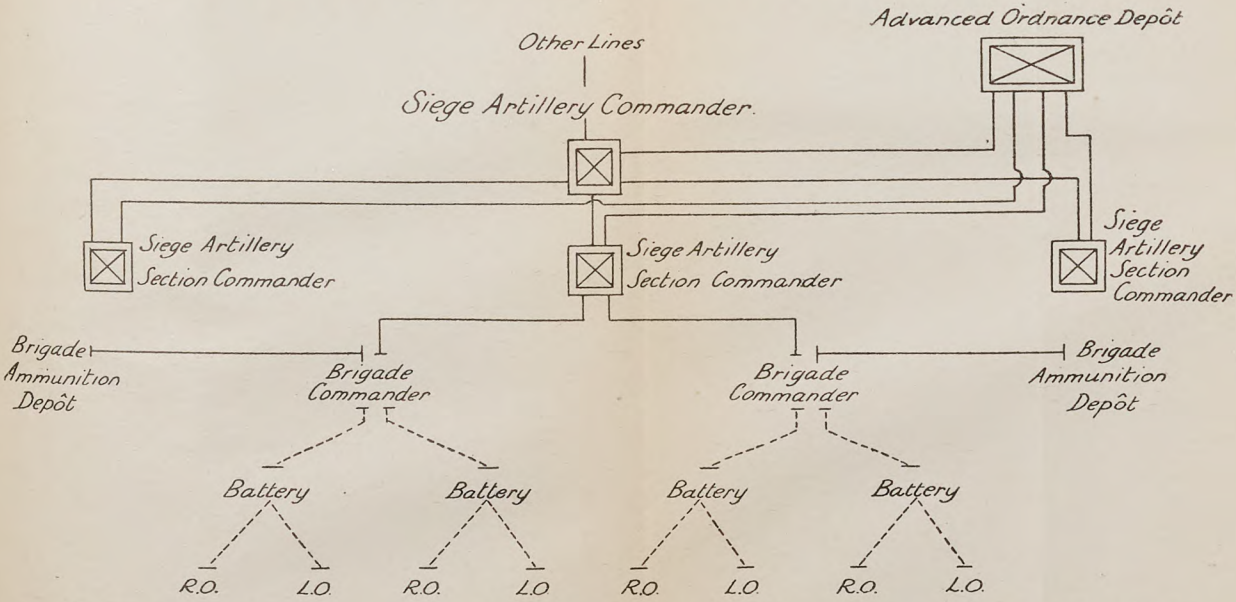
To face page 144.

DIAGRAM OF TELEPHONIC COMMUNICATIONS BETWEEN THE SIEGE ARTILLERY COMMANDER, HIS SUBORDINATE ARTILLERY COMMANDERS AND THE ADVANCED ORDNANCE DEPÔT.



NOTE.—The lines shown continuous will be installed by the R.E. The lines shown dotted will be installed by the R.A. Communications for two Brigade Commands only are shown.

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mander and an brigade ammunition depôt, which should be in communication with the advanced ordnance depôt.

2. All communications should be completely installed and in working order before the arming of the batteries concerned is finished.

3. Down to and including the artillery brigade commanders, the telephone system is erected by the R.E. The remaining communications are installed and maintained by the R.A.

Whenever possible communications should be duplicated, both telephonic and signalling systems being arranged.

63. *Position of observing stations.*

1. *Observing stations, i.e.*, posts from which it is intended to observe the effect of fire, should be selected with the greatest care. They should, when possible, be near the batteries they serve, so that the observation can be carried out by the simplest means, and as the effect of fire will largely depend on the accuracy of observation, it may often, if not usually, be advisable to select the observation stations first, and afterwards fix the site for the battery near one of them. This procedure is not incompatible with obtaining a position from which effective fire can be opened, for a wide field of selection is usually available, especially when batteries are to fire from behind cover, and an artillery commander is always given considerable latitude in the selection of his positions.

2. It is not necessary that the two observing stations should be at the same distance from the target and the battery. One observing station should, if possible, be close to the line of fire, as the nearer it is the more accurate and

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simple are the observations for line, and the two stations are usually though not necessarily placed on opposite sides of the line of fire. When both stations are on the same side of the battery the distance from the battery to the nearer line of observation should not exceed $\frac{1}{6}$th of the range, though fair results have been obtained up to $\frac{1}{4}$th.

3. Theoretically the greater the effective base, *i.e.*, the distance between observers at equal distances from the target, the better should be the observation ; but long bases have the following disadvantages :—Long lines of telephone wires which are liable to break down, difficulty in getting the two observers on to the same object for observing shots falling over or short of the target whilst the field of view of the telescope is more limited.

Practically it has been found that the best results are obtained with a base from $\frac{1}{4}$th to $\frac{1}{6}$th of the range, but good results have been obtained with a base $\frac{1}{10}$th of the range.

4. All observing stations must be placed in commanding positions whence a good view of the country in front can be obtained, but they should not be placed on the sky line, should not be so conspicuous as to disclose their position and invite attack, and advantage should be taken of all natural cover. As a general rule cover from weather should be provided for the observer, and for the relief in a concealed position in the vicinity of the observing station. In certain circumstances it may, however, be necessary to dig regular emplacements for the instruments, with overhead cover capable of keeping out shrapnel bullets, arrangements being made so that the field of view is not thereby too much restricted.

The observers in each pair of stations should, if possible, see each other, but this is not essential.

5. If neither observer is close to the battery the observa-

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tion for line will only be an accurate measure of the corrections necessary for the guns when the range is found. It may, in this case, be desirable to arrange for a third observer some distance to the rear (or he may even, under certain conditions, be in front), to observe for line only.

The indication of targets and the direction of fire will be facilitated if one of the observing stations of each battery is near the brigade commander's position.

6. Observing instruments when once set up should not again be moved.

7. *Central Observatories* for the purpose of observing the enemy's movements, lines, and works of defence, &c., will generally be placed for convenience on suitable points in, or in rear of, the line of investment.

64. *Arming siege batteries.*

1. If it be necessary to employ batteries in any but concealed positions they would, as a rule, be armed under cover of darkness.

2. Before arming batteries by night is is essential that the officer charged with the carrying out of the operations should satisfy himself on the following points, viz. :—

(i) That the roads or lines of communication between the gun park and various gun emplacements are practicable.

(ii) That those on whom will devolve the conducting of the teams or tractors have made themselves thoroughly acquainted with the line of roadway they are to follow, especially with regard to any difficulties they may have to overcome on the way to the different emplacements.

(iii) That the more difficult portions of the road have been marked with patches of white, or lanterns screened from the enemy to enable the drivers to keep the track after dark.

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(iv) That all stores are complete to enable the battery to open fire at once, if necessary.

(v) That officers concerned have been furnished with written orders, as to the hour they are to move off, the order of succession of the different carriages, the route they are to follow, both going and returning, and the particular site each piece is to occupy.

(vi) That those in charge of teams or tractors have been clearly instructed as to the way in which the teams or tractors have been allotted, and that they have, before dark, made themselves acquainted with the exact position of the several carriages to be horsed.

(vii) That every precaution has been taken to guard against confusion or a block on the road, and for the speedy extraction of howitzers or carriages that may be in difficulties.

(viii) That it has been impressed on all that noise or the flashing of lights is liable to draw the enemy's fire, and must therefore be avoided.

The above instructions are also generally applicable to arming batteries by day.

3. When the attacking batteries are concealed, opportunity is afforded for the careful selection of auxiliary marks and for the completion of those minor arrangements in the batteries which can be more satisfactory carried out by daylight. It is most important to have everything ready before opening fire.

4. Howitzers mounted on travelling carriages should only be placed in the firing position in the park when the road to the batteries is exceptionally sound, and there is not the slightest chance of a stoppage. Should there be any doubt whatever of the capability of the road to stand the traffic, precautions should be taken to support the wheels of the

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heavier pieces with brushwood, planks, sods, sandbags, sleepers, or whatever material there is at hand.

5. The labour and time expended in extricating heavy ordnance, when their carriage wheels have sunk, is considerably greater than that which would have had to be expended in making the road good at first, or in moving the howitzer by some slower though more certain way. Besides, a stoppage of this kind is likely to block the road, and so throw out the whole of the arrangements for arming the batteries. When the ground is very bad indeed, a "corduroy road" may be formed. This is made by placing sleepers or planks at right angles to the direction of the road and about 6 inches apart; if the amount of material available is small, the sleepers may, when the gun has passed over them, be carried from the rear to the front and relaid. By this somewhat slow and laborious method, heavy pieces may be man-handled over almost any kind of ground.

Special care should be taken in turning corners, as in doing so much extra weight is thrown on one wheel.

6. When a gun has stuck an extra team should be hooked in, and all available men put on to ropes to assist. Drag-ropes are not always strong enough, and a 4½-inch rope will be found of great use for this purpose. If the ground is very stiff it will usually be a good plan to dig out in front of the wheels, but this is not usually advisable. If these expedients do not succeed, it may be found quicker to sling the gun by means of a light gyn, with its feet well supported, and to place planks under the wheels, than to attempt to use jacks; when, however, the ground is very soft, it is not practicable to use a gyn.

7. In lowering howitzers or wagons down sharp inclines, two drag ropes made fast to the tyres of the wheels and a round turn taken through the trail handles will be found to

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act as an efficient brake. The ropes can be shifted as required by scotching the wheels or removing one rope at a time.

8. It sometimes happens that in soft ground, when using wheel purchases, the wheels will skid round without moving the weight. This can be obviated by winding a drag-rope or piece of lashing round the tyres which will tend to cause the wheel to bite in the ground.

9. One limber complete should be taken down into each battery, as it contains most of the stores necessary for the service of the piece.

65. *Storage and supply of ammunition.*

1. In considering the approximate amount of ammunition required for the different pieces employed, no hard-and-fast rule can be laid down, as the quantity will depend on :—

(*a*) The number, strength, disposition, and armament of the works to be attacked.

(*b*) The strength, composition, and efficiency of the garrison.

(*c*) The number and nature (especially as regards accuracy and shell-power) of the pieces available for the siege.

2. During the earlier operations of a siege the siege artillery will probably consist of mobile medium howitzer batteries and the heavy batteries, and since it may be assumed that fire is likely to be as rapid as is consistent with accuracy, with the object of obtaining fire superiority over the defenders' artillery, the expenditure of ammunition may amount to 100 or even 200 rounds per gun a day.

3. Heavy batteries and mobile medium howitzer batteries are provided with ammunition columns, and the system of

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ammunition supply during the initial stage of the siege will therefore conform to that of field artillery.

4. As soon as regular siege operations commence, arrangements must be made for the supply of ammunition from depôts which must be formed as soon as the investment is complete.

5. However wide the front of attack may be, it will generally be convenient to have but the one advanced ordnance depôt.

6. Up to and including the advanced ordnance depôt which will form part of the advanced depôt, the supply of ammunition is under the control of the ordnance department, who are responsible that the quantity maintained should never fall below 750 rounds per siege gun.

7. The first provision of ammunition should also not be less than 750 rounds per gun, including ammunition held in the ordnance depôt, in brigade ammunition depôts, and in expense shell stores, &c.

8. All ammunition will be drawn by the siege artillery commander from the advanced ordnance depôt, and from this point to the guns the supply of ammunition will be controlled by him.

9. The ammunition taken over at the advanced ordnance depôt will be forwarded to the various brigade ammunition depôts, which will be constructed in suitable positions. The number of these will vary according to circumstances, but will usually be one to each brigade or equivalent number of guns.

10. From these brigade ammunition depôts each battery will be supplied, the ammunition being stored in expense shell stores and magazines, which will be constructed at the same time as the battery.

11. As a general principle the wagon detail of mobile units

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will work the ammunition from the brigade ammunition depôts to the battery expense stores, and the ammunition column detail will work the ammunition from the advanced ordnance depôt to the brigade ammunition depôts. In the case of units not originally organized as mobile batteries special provisions will be made for ammunition detail on mobilization.

12. Brigade ammunition depôts should if possible be connected with the advance ordnance depôt and with the batteries they are intended to supply by lines of siege tramways. The brigade ammunition depôts will contain the supplies required for 24 hours' firing, and will be in charge of their respective brigade commanders.

13. A further 24 hours' supply being kept in expense magazines and shell stores and battery recesses.

14. Compact arrangement and separation of stores according to their uses should be arranged for at depôts. The heavier stores should be placed in positions from which they can most easily be moved.

15. The depôts should be in telephonic communication with the brigade commanders, the batteries and the advanced ordnance depôt.

16. The siege artillery brigade commander is responsible for the selection of the position for the brigade ammunition depôt, which should be sited with due regard to :—

i. Concealment.
ii. Safety from artillery fire.
iii. Security from surprise.
iv. Facilities for receipt and issue of ammunition by concealed routes.

No hard and fast rules can be laid down as to the distance the brigade ammunition depôt should be from the batteries.

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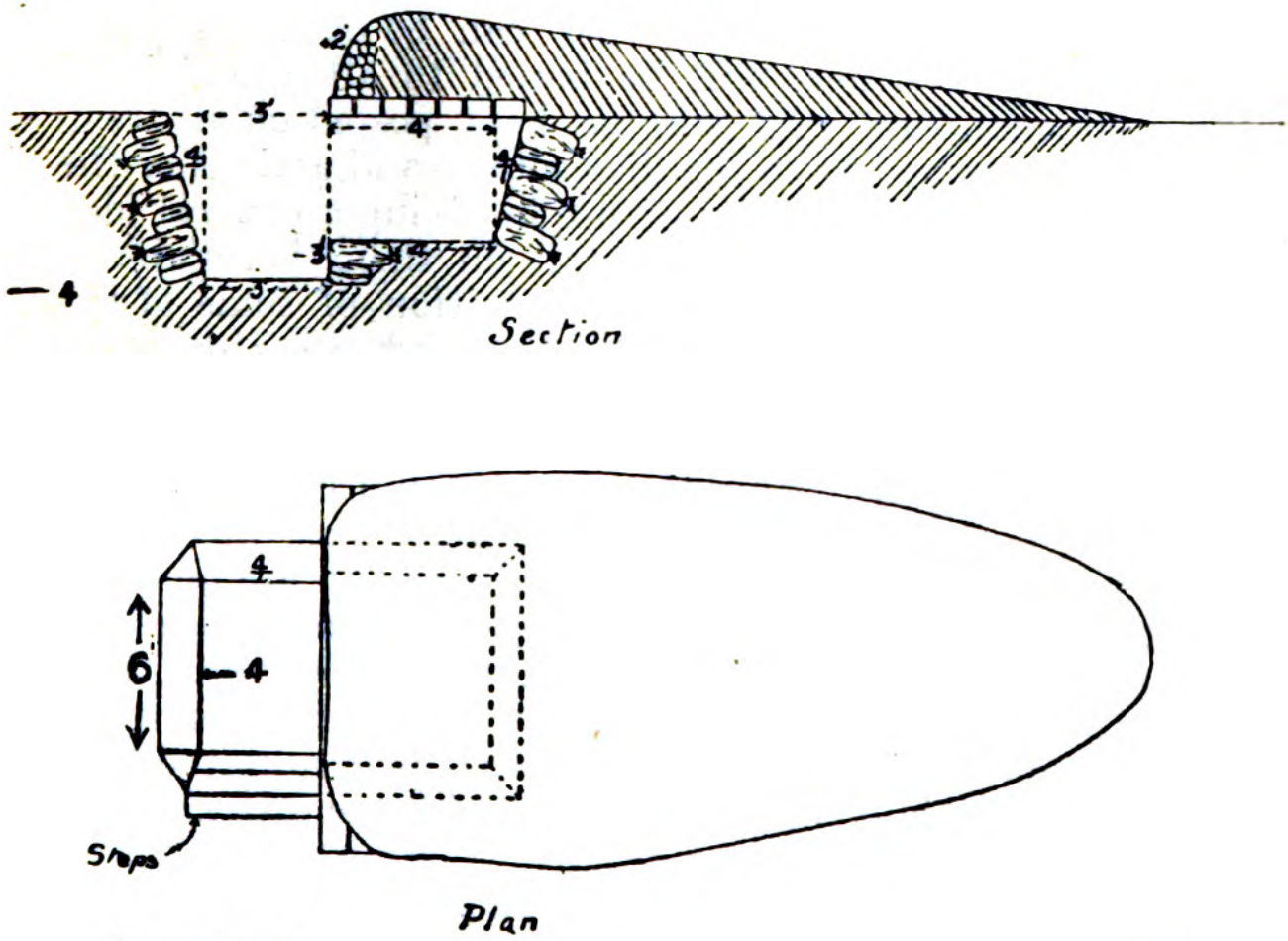
17. Each battery commander will forward daily to the brigade commander a statement of ammunition expended, amount remaining, and amount required for the next day's supply. The brigade commander will forward similar statements daily to the siege artillery commander, who will arrange for the necessary ammunition to be supplied from the advance ordnance depôt direct to the various brigade ammunition depôts, whence the ammunition will be forwarded to the batteries as required.

18. A simple type of shell store to hold 50 shells, and also provide cover for the shell numbers of one gun, is shown in Fig. 16.

FIG. 16.



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A pit is dug out to the dimensions shown, the sides and ends are revetted with sandbags, and steps formed at one side. One end of the pit is then covered in with six sleepers, and earth is thrown up on the latter to a height of one foot six inches above the sleepers. Planks should be placed for the shell to rest on, and arrangements made for drainage.

Six men should make such a pit in about three hours.

Plates II, III and IV show a type of sunken battery for 6″ B.L. howitzers.

66. *Indication and allotment of targets.*

1. Maps showing the dispositions of the enemy, so far as they can be ascertained, and, if they can be obtained, plans of his forts or positions will be issued to all brigade and battery commanders, who will be kept posted on all fresh information obtained as to the dispositions and actions of the enemy. Such maps will be of use in giving a general idea of the situation, and—if the detail on them is reliable—perhaps a rough indication of the position of some of the enemy's concealed guns. Suitably prepared maps or plans may be of use for the general allotment and indication of targets.

2. The difficulty of finding the enemy's concealed guns is common to both assailants and defenders, and until their position is known ranging is impossible; and to fire on them without an accurate knowledge of their position must result in a large expenditure of ammunition to no purpose. This difficulty may, however, be overcome by means of observation from a balloon or kite. Such observation will admit of the line of fire being laid out, under favourable conditions, with a considerable degree of accuracy.

3. Balloons have one great drawback: they cannot be

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made use of in windy weather, and even with a moderate wind accurate observation from them is very difficult.

Kites can, however, be used in a strong wind, and they are steadier for observation purposes.

4. The siege artillery commander is responsible for the general control and distribution of the fire of the siege artillery brigades.

5. The brigade commander will apportion and indicate the target to each battery commander, the actual direction of fire being the duty of the latter.

To indicate the target various methods may be employed, of which the simplest is to personally point out to the battery commander the target; or an officer or trained orderly may be sent to the battery commander and to each of his observers, to show him the target; or again the target may be described through the telephone.

6. When there is difficulty in locating a target either from the battery, or from the position of its observers, another battery, in a more favourable position, may be ordered to mark the target by firing a few rounds at it.

7. When none of these methods is suitable, recourse will usually be had to the field plotter as a means of indicating the target.

Either to the front of or rear of each battery, as may be most convenient, will have been placed a director, in a covered position if possible, which will have been marked by a signalling flag, or in some other suitable manner.

The position of one of the brigade commander's observers should also have been selected so that all the battery directors are visible from it, and should have been marked in such a manner that all batteries can locate it without chance of error. This station is usually known as the brigade commander's "line observer."

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In order to direct the fire of any one of his batteries on to any portion of the target, the brigade commander can either ascertain its "battery angle" and range, by means of his field plotter, which will then be communicated to the battery commander; or as an alternative method information may be given to the battery commander as to the range from the brigade commander's station, and as to the included angle, the battery commander working out his own battery angle.

8. If time is of great importance the brigade commander may order the battery commander to commence firing as soon as he has received his range and angle to the target, the first few rounds being observed by the brigade commander's observers.

9. When a battery is in a position to pick up the line of fire from behind the guns, the information sent by the brigade commander may merely be made use of to indicate the target roughly, the line for each gun being found by trial. In other circumstances, the line can be laid out by the director in the ordinary way, or the method described in Section 13 may be employed when suitable.

10. If one of the observers of any battery is in such a position that his instrument can conveniently be used as a director for giving angles to the guns, it should be so employed, and the director will not then be required. The brigade commander will, in that case, take the angle and distance to this instrument instead of to the director.

11. In order that there may be no doubt as to which side the battery angle sent to a battery should be laid off when the angle is a small one, the word "right" or "left" should be given with this angle, according as the battery director (or observing instrument, if used instead) is to the right or left of the line from the "brigade commander's line observer" to "target."

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12. Any one of the above methods may be used according to circumstances, but when there is a choice the simplest should be selected ; often a combination of two or more may be employed.

67. *Rate of fire.*

1. The rate of fire to be maintained by each battery, and when necessary, the order in which each battery is to fire will be notified to battery commanders. It must be remembered that slow, continuous and accurate fire is more effective than faster but intermittent fire, for the enemy is accorded fewer opportunities of executing repairs undisturbed and observation of fire is facilitated. The batteries of a brigade should open fire simultaneously, as the difficulty of locating them is thereby increased, and the chances of a concentrated fire being brought to bear on one battery diminished.

2. When more. than one battery is firing at the same target arrangements must be made for regulating the fire in order to prevent confusion in observation.

3. The nature of projectile to be employed will also be ordered by the brigade commander in accordance with the general principles discussed in Section 60.

68. *Battery commander.*

1. The duties of the battery commander may be summarized as follows :—

The selection, in conjunction with the brigade commander of positions for batteries and for observing stations.—In certain circumstances, the commander of a detached section of guns might be ordered to carry out this duty himself ; and in any case, the selection once made, any subsequent small change of position of either the guns or the observing stations becomes a matter for the battery commander to deal with.

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2. *The provision of cover from fire and weather, both for the gun detachments and the observers.*

3. *The decision as to the method of observation of fire to be employed.*—The considerations which govern the choice of method are explained in Chapter V, and it is only necessary to note here that instrumental observation should not be employed unless it can be ensured that the instruments of both observers are directed on exactly the same point. In many cases visual observation will give perfectly satisfactory results, and when that is so it should be employed. Often both forms of observation will be carried on simultaneously, the one acting as a check on the other.

4. One of the most difficult, and at the same time most important duties of the battery commander, is to ensure that when instrumental observation is employed observing instruments are directed on to the target, and then securely clamped.

Various methods or a combination of two or more methods can be used for this purpose, the system actually employed depending upon the procedure by which the target has been indicated to the battery commander by the brigade commander. If the brigade commander has communicated the angle to the target from the battery director, the battery commander will first have to locate the target himself and then arrange to put both of his observers on to it; but if the brigade commander has given the angle from one of the battery observers to the target, it will only be necessary to point out the target to the other observer.

5. In the first case, if the target is easily distinguished, its position may be explained to the observers by telephone, or, if this cannot be done, an officer or non-commissioned officer can be sent to the observers to point out the target. In the case of very difficult targets it may be found best to tele-

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phone a description of the target, and then to commence firing, directing the observers to pick up the target by noting the fall of the shells. In some cases the brigade commander's observers should in the first place undertake the duty of observation, the battery observers picking up the target as soon as they can.

6. When the target is indicated by the fire of another battery the observers will also pick it up in this way, and report to the battery commander when they are clamped on it.

7. When the target has been indicated by the brigade commander to one of the battery observers, the other observer can be easily put on to it by means of the field plotter, for the battery commander will know the distance between his observers, the distance from one of them to the target, and can measure the angle between these two lines.

8. In all cases the brigade commander should be informed as soon as the observers are both clamped on the target.

9. *Laying out the line of fire and finding the range.*—Laying out the line of fire is described fully in Chapter III, and all that need be said here is that when there is a choice of methods the simplest should be selected, and when one of the observing instruments can be conveniently employed as a director this should be done.

10. It should be noted, however, that it is not essential that the line of fire should be laid out on to the same point that the instruments are directed. It will often save time, in the case of targets which are difficult to distinguish except through low-power field glasses (a very probable condition in hazy weather), to lay out the line on to some easily discernible object in the direction of the target, and to order whatever deflection may be necessary to bring the fire on to the target.

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11. The range can be found either by rangefinder or by the observation instruments. When time is a consideration the quickest method should be selected, in other circumstances the instruments should be employed as being more accurate.

12. *Observing fire.*—The effect of the shooting depends almost entirely on the accuracy of the observation of fire, and the subject is fully considered in Chapter V.

It will, however, be desirable to emphasize the fact that the battery commander must observe fire, not only for purposes of ranging, but to ascertain its effect upon the target and upon the course of the action. For instance, if a target is destroyed or withdrawn it is obviously useless to continue firing at it ; again, when supporting an assault, fire must be so regulated that whilst the greatest possible assistance will be afforded to the attacking infantry, the risk of causing casualties amongst them will be reduced to the lowest possible limits.

It would seem then that the battery commander's position should be where he can see the target, even if this necessitates his being a considerable distance from his guns.

13. *Ranging.*—The process of ranging is described in Chapter VI.

14. *Supply of ammunition.*—Battery commanders are responsible for demanding from the brigade commander sufficient ammunition to keep their expense stores full.

15. *Siege howitzers with the field army.*—When siege howitzers form part of the field army the duties of the battery commander may include fire control as well as fire direction.

16. *Detached sections.*—When sections are detached, the section commander is responsible for the fire direction of his section, and possibly for fire control also.

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69. *Reliefs.*

1. To prevent the enemy from re-arming or from repairing damage done during the day, siege artillery fire must be continued both by day and night, though by night only half the guns will usually be manned. It will therefore generally be found convenient to divide the personnel required to serve each battery of the brigade into three reliefs, each relief being on duty for 24 hours.

2. A relief will be on duty on the guns for 24 hours, will then be off duty for 24 hours, and during the 24 hours prior to coming on duty again on the guns will be available for ammunition fatigues. Reliefs should be made at the breakfast hour, and meals should be sent to the men on duty in the battery.

3. The reliefs for officers will have to be specially arranged, but section commanders should always go on duty with their own sections.

4. In carrying out reliefs the following points must be attended to :—

The relief must be carried out as quickly and quietly as possible, so that the extra men are kept under fire for the shortest possible time.

The arrangements should be such that little or no interruption is caused in the fire of the batteries.

All necessary information must be passed to the relieving detachments so that the work can be carried on without hesitation or delay.

Relieving detachments will be halted in a selected position clear of the batteries and left under charge of the senior section commander.

The relieving battery commander will proceed into the battery and take with him the Nos. 1 of detachments. The former will take over the ranging sheet and all orders

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regarding the conduct of fire, and send the Nos. 1 to their respective guns, where they will make themselves acquainted with the setting of the sights, laying points, ammunition, &c., &c.

5. As soon as the battery commander has satisfied himself that he and his Nos. 1 are in possession of all necessary information, he will send orders for the relieving detachments to be brought up.

These will at once form in rear of their respective guns and the relief will be completed without delay, section commanders being held responsible that the old detachments are at once moved clear of the battery.

6. The relieving battery commander will report his arrival by telephone to the brigade commander, and the battery commander who is being relieved will report himself to the brigade commander by telephone before he leaves the battery.

7. Owing to the exacting nature of their functions observers cannot remain for such long periods on duty, and at least two men, who relieve each other at frequent intervals, must be on duty at one time. In these circumstances it is best to permanently detail three men to each observing station, who arrange reliefs among themselves, or, as an alternative, reliefs can be arranged between plotters and observers. A similar system may be followed in the case of telephonists.

Employment of Siege Artillery in Defence.

70. *General principles.*

1. An active defence is the very soul of the operations of the besieged. The greater the energy and resource displayed

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by the defenders the longer will the investment be delayed, and the more protracted will be the siege.

2. With the object of delaying the investment one or more advanced positions will be occupied in front of the main line of defence. The distance of an advanced position in front of the main line of defence cannot be precisely laid down, and will vary with the nature of the ground, strength and *morale* of the defenders. It must be far enough forward to deny to the enemy artillery positions from which fire can be opened against the main line of defence, and should be strengthened by all artificial means available. In the advanced position will be placed the heavier guns of the movable armament, the light guns being employed in the counter-attacks that will be continually made from it, with a view of inflicting loss upon the enemy's personnel, damaging his entrenchments and artillery, and hindering the establishment of his batteries.

3. In these preliminary operations, the batteries of the movable armament will be guided in their action by the rules which regulate the operation of field artillery.

4. As the positions taken up will only be temporary, the siege batteries must be prepared for an advance or retirement at short notice. No platforms will therefore be laid, and positions will be selected with a view to their suitability not only for fire action, but also for case of access to roads or to ground suitable for subsequent movement.

5. Howitzers employed must be so placed that they can easily and rapidly change from one target to another. If natural cover cannot be obtained, works with low parapets and deep trenches for the detachments should be constructed and should be artificially screened as far as possible.

6. In advanced positions it is probable that observation of fire will frequently be carried out without instruments, or if

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they are used, the bases will be short and communication will be by visual signalling rather than by telephone.

7. As the assailants make good the ground in their front the troops occupying the last of the advanced positions will fall back under cover of the fire of the artillery of the main line of defence, consisting of the fortress guns and the movable armament guns.

These batteries are sited and are distributed amongst sections of the main line of defence on the same principles as have been explained in the case of the attack.

8. When the besieging troops begin the investment, fire will be directed on their trenches, parallels, and working parties, and on the guns as soon as ever they can be located, by means of spies, of balloons, or other aerial vessels, &c.

9. The principle to be followed by the artillery of the defence will be concentration of fire on successive objectives as being more effective than general distribution of fire over an extended front.

10. As soon as the direction of the main attack has been made clear, the artillery on this front will be reinforced by all the guns that can be spared from elsewhere. The disposition of this armament will vary according to local conditions, the howitzers, for instance, will be placed on platforms, well concealed and protected, while for light Q.F. guns, positions will be prepared from which they can fire direct against the moving targets that may appear. In each position a record should be kept of the ranges to all prominent objects on which the gun bears; the line of fire to such objects being marked in the most convenient way.

11. Both high explosive and shrapnel shell will be used at almost every stage of the defence, but in the earlier stages the use of shrapnel will predominate. The same general rules apply to the use of these projectiles in the defence as

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in the attack; high explosive shell being employed against material, and shrapnel fire against personnel. The actual conditions of the fight will determine which projectile is likely to produce the greater effect. At night star shell for the howitzers may, in certain circumstances, be found of use to supplement any search lights that may be available.

71. *Siting of works and batteries.*

1. Most if not all the work of siting and arming batteries, selecting observing stations, laying communication, arranging for magazines and shell stores, and for their replenishment by rail, trolley, or other means, will have been carried out in peace on the principles explained in Sections 63, 64 and 65.

2. At the same time every possible means and artifice will have been employed to protect personnel and material by measures calculated to conceal them from an enemy and to deceive him as to the position of works and guns, alternative emplacements being prepared for the latter since change of position is the chief safeguard against damage to armament.

3. Similarly search lights will have been placed in positions where they cannot easily be damaged by hostile fire, but will illuminate ground favourable to an attacker.

Employment of Siege Artillery in Minor Siege Operations.

72. *General principles.*

1. It is possible that the British Army may be called upon to undertake siege operations on a smaller scale than would

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be required in the attack or defence of a modern first-class fortress such as :—

(*a*) Bombardment, probably at very long ranges, of docks, naval establishments, and torpedo boat stations; also of hostile ships lying in defended ports.
(*b*) Silencing coast defence batteries.
(*c*) The attack of permanent, or semi-permanent, detached works, with a view to their seizure by infantry.
(*d*) Attack by siege howitzers on the field works of fortified positions, in aid of the field artillery.

2. It is hardly possible to lay down in detail the precise manner in which artillery will be used under the varying conditions enumerated in the foregoing paragraph. A great deal must depend upon the local conditions, the configuration of the ground, and the amount of resistance offered. The same principles, however, govern procedure whether the attack is directed against a powerful fortress, or whether minor siege operations are being undertaken; but the method of applying these principles will vary according to the particular circumstances of each case.

3. In the defence the general principles explained in Section 70 hold good, but positions far in advance of the main defensive line cannot be occupied, and it may even happen that the defenders may be unable to attempt more than to hold the line of the permanent, or semi-permanent, works of defence. Even in such cases it is most important, especially in the earlier stages of the fighting, to push forward whatever troops can be spared, so as to delay the assailants and make the defence as active as possible.

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APPENDIX I.

Description of Instruments.

73. *Observation of fire instruments.*

(Plates V and VI.)

The right and left observing instruments are in all respects identical.

The instrument consists of a bedplate A revolving on a vertical spindle inside the upright B. A thick plate with 360 teeth cut on its edge moves inside this bedplate. (The thick plate and upright are in one casting.) Gearing into the teeth is a screw which is revolved by the handle F.

One revolution of the handle moves the plate through 1º.

This screw is pivoted at one end, and is capable of being put in or out of gear with the teeth of the plate by a lever R, so as to allow of rapid motion when required.

Fixed to the screw is a wheel V divided into 60 parts, each part therefore representing one minute of angle. A loose wheel W divided in the same manner, with white and black lines, can be clamped into any position, so that when the telescope is directed on the target, angles right and left of this can be at once read off. The white lines give angles to the right, the black lines give angles to the left, as seen through the telescope.

Turning the handle D clamps the socket, in which the screw C works, to the lower plate G. Slow motion can be given to the bedplate by turning the screw C. Fixed to the bedplate is a bracket carrying the telescope K.

Motion in a vertical direction is given to the telescope by

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turning the wheel M, the amount of inclination can be read in degrees on the graduated arc L, and in minutes on the wheel M.

A circular bubble N is fixed in the centre of the bedplate A. When the bubble coincides with the engraved circular ring the upper surface of the bedplate is approximately level in all directions.

Before taking angles of sight with this instrument in any direction, it is necessary first to take the index error of the bubble in that direction (*see* p. 190), and to correct the angle of sight for index error before sending it in.

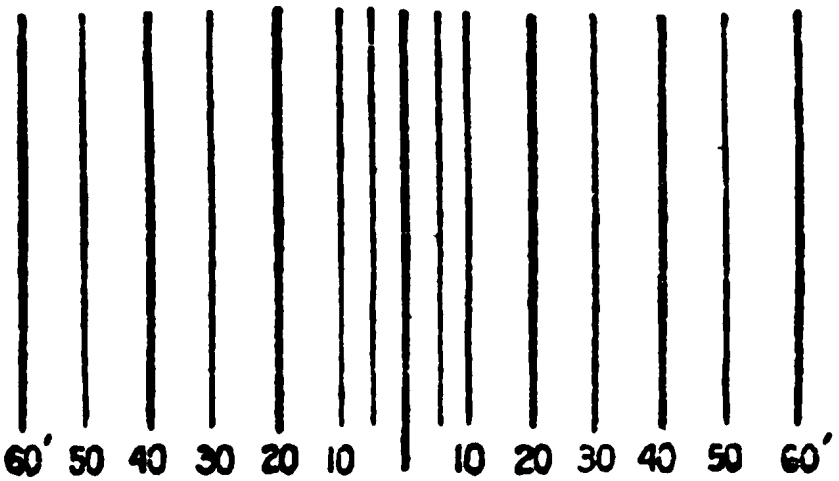
The telescope KK is designed to give a large field of view, viz. 2°, with a magnifying power of 15 to 1.

The cap projects some distance from the object glass, and can be drawn still further out to prevent driving rain getting on the glass.

Sights on the upper surface of the telescope are provided for rough laying.

The diaphragm is marked as shown in the figure below by thick and thin spiders' webs.

A spare diaphragm is provided in the case.



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A socket S serves for the small electric lamp which illuminates the spiders' webs. An alternative method of illuminating the webs is by means of a window T through which the light from a lantern can be thrown upon the webs. By turning the brass ring T the window is covered. The eye-piece of the telescope can be withdrawn by partially turning it when fully drawn out, there being a bayonet joint cut in the outer tube for this purpose.

The screws QQ with fly nuts are provided for fixing the sighting arm PO. The sighting arm is made of a T section to give rigidity and lightness. The eye-hole P and sight bar O are hinged so as to be flat on the bar when folded down.

The base piece GGG with three steel feet fits into the tripod head HHH, and a locking plate clamped by the screw X secures the instrument.

The tripod is of the usual form, but a hinged foot is provided to prevent the feet slipping, and, if necessary, to drive a nail through each, when the instrument is set up on a smooth surface. Each instrument, and each separate part of it, is numbered.

A magnetic compass is fitted on the bed-plate A, and is used for setting up the instrument to the magnetic north.

At night the graticules must be illuminated either by the electric lamp or by a bulls-eye lantern held to the small window at the telescope. The proper degree of illumination has been attained when the graticules appear as bright lines on an almost perfectly dark field.

The following is a description of the electric lamp and its accessories.

The switch and resistance coil, Mark IV (Figs. 17 and 18), consists of a base-board, which has fixed upon it an

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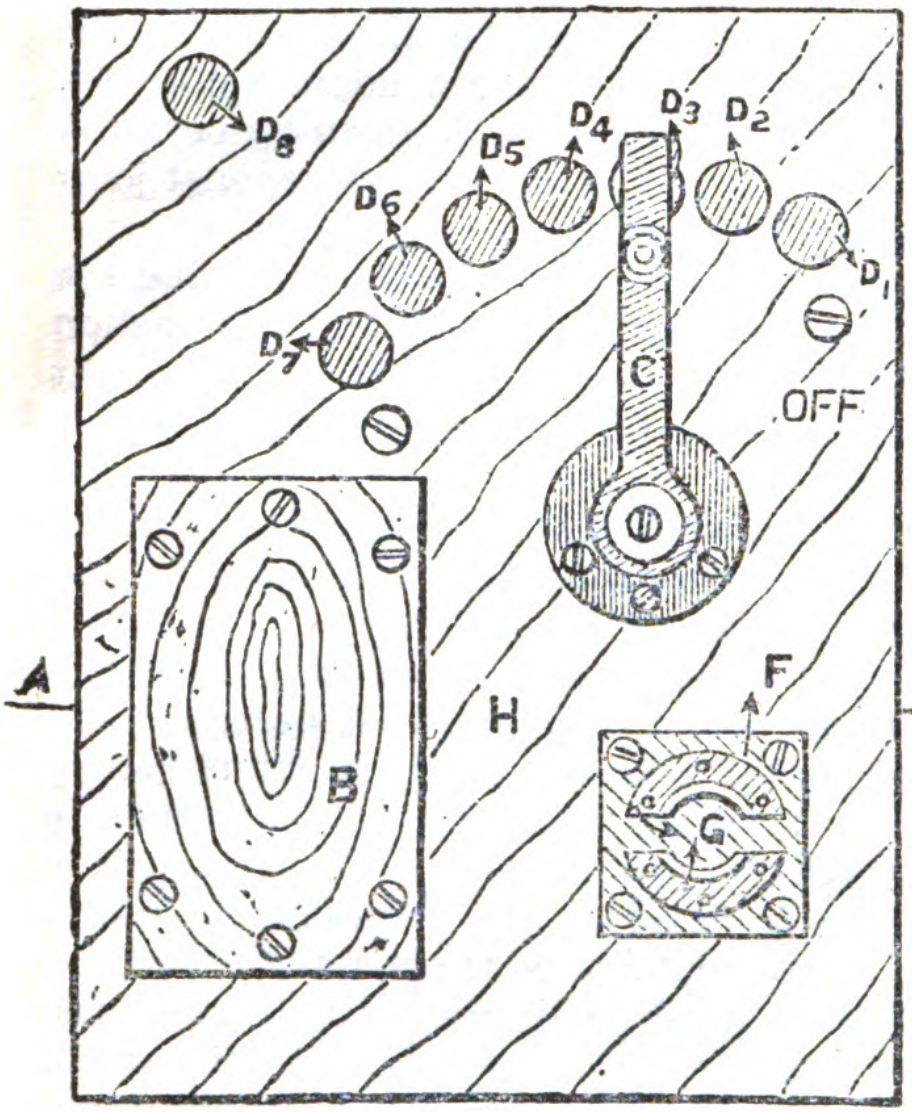
FIG. 17.
SWITCH AND RESISTANCE COIL (MARK IV.).

Plan. *Scale* ½



A.—Ebonite bobbin.
B.—Wood cover.
C.—Lever,
D_1.—D_7.—Studs.
D_8.—Stop stud.
E.—Contact piece.
F.—Ebonite block.
G.—Brass socket.
H.—Base board.

Section through A. B.

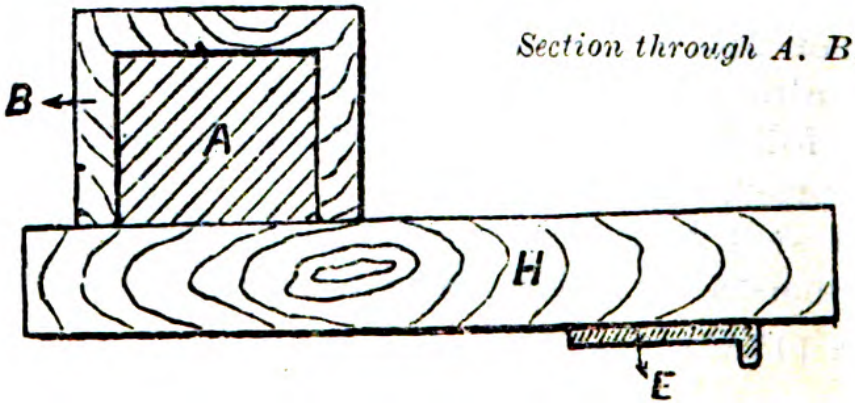


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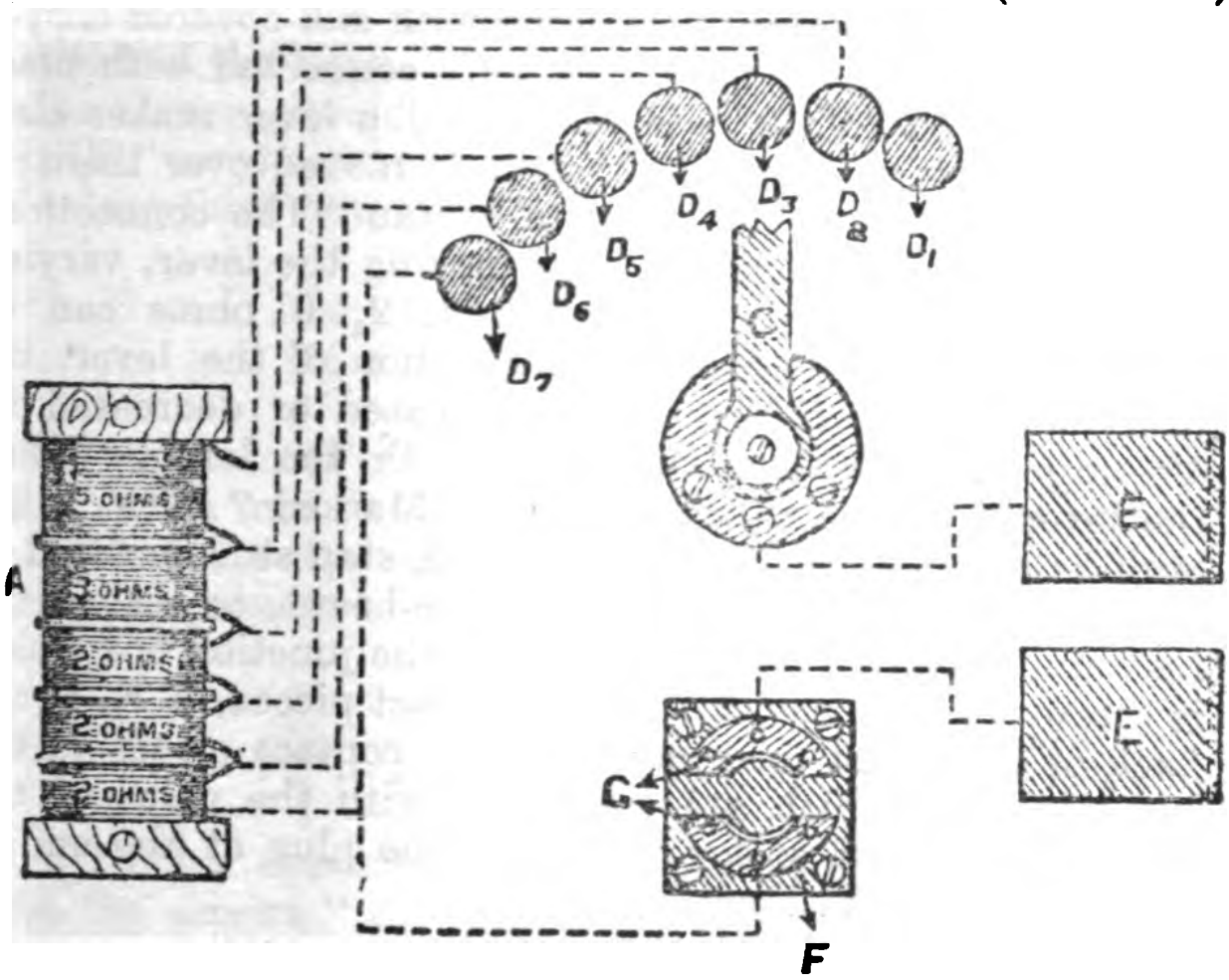
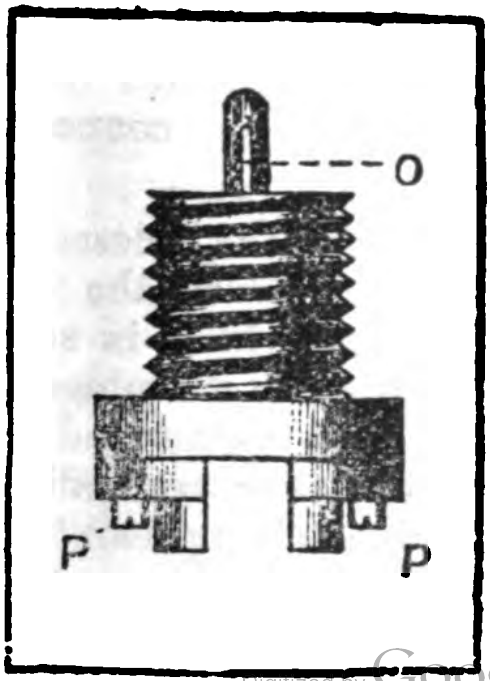
FIG. 18.

CONNECTIONS OF SWITCH AND RESISTANCE COIL (MARK IV.).





LAMP.

A.—Ebonite bobbin.

C.—Lever.

D_1.—D_7.—Studs.

E_2E.—Contact pieces.

F.—Ebonite block.

G.—Brass socket.

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ebonite bobbin, wound in sections with silk-covered copper wire. The sections are electrically connected with brass studs mounted on the base-board, and a lever makes electrical contact with the studs as it is moved over them; a wood cover fits over the ebonite bobbin. The connections are shown in the diagrams. By moving the lever, varying resistances of infinity, 14, 9, 6, 4, 2, 0 ohms can be obtained, and, according to the position of the lever, the brilliancy of the light can be increased or decreased by altering the resistance in circuit with the lamp. When the lever is on the right hand stud (Marked " OFF ") the lamp is out of the battery circuit. A stop stud is fitted at the left hand top corner of the base-board, to insure the instrument being placed correctly in the junction box which is screwed to the battery. Two contact pieces, E E, at the back of the board form contact with contact pieces in the junction box, which are connected with the poles of the battery. A brass socket, G, holds the plug at the end of the leads from the lamp.

The lamp consists of an ebonite plug, which screws into a brass socket in the body of the telescope, near to the diaphragm carrying the graticules. Fixed in this plug is a small 4-volt incandescent lamp, O, connected to brass sockets, P P.

To use, screw the lamp into the telescope, place the " switch and resistance coil " (with the brass lever at " OFF ") in the junction box which is screwed to the battery, and connect up by placing the plugs at either end of the flexible lead in the lamp socket and switch socket respectively. Now move the lever gradually to the left, until the right light is obtained, being careful not to push

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the lever over *too quickly* or *too far*, as by so doing the filament of the lamp is liable to be fused.

The lever should be kept on the end stud marked " OFF " except when actually observing, as the batteries soon lose their power.

To place instrument in box.

The diagram (Fig. 19) shows the method of packing the instruments into the box. Place instrument in box so that projection A butts against wood block B, the slow motion traversing handle being to the left.

To place sighting arm in box.

Fold down eye-holes and sight bar, turn the arm on its side, the screws " c " and " d " uppermost, and the eye-holes and sight bar towards the instrument; the arm will then slip into the fittings provided for it in the box.

Care of instruments.

The greatest care of the instruments must be taken at all times, whether in quarters or in the field. Any accidental damage to them must be at once reported. They must be kept clean and free from rust, and if brought in wet must be carefully dried with soft rag, and the working parts then lightly oiled with best rangoon oil. The lenses must never

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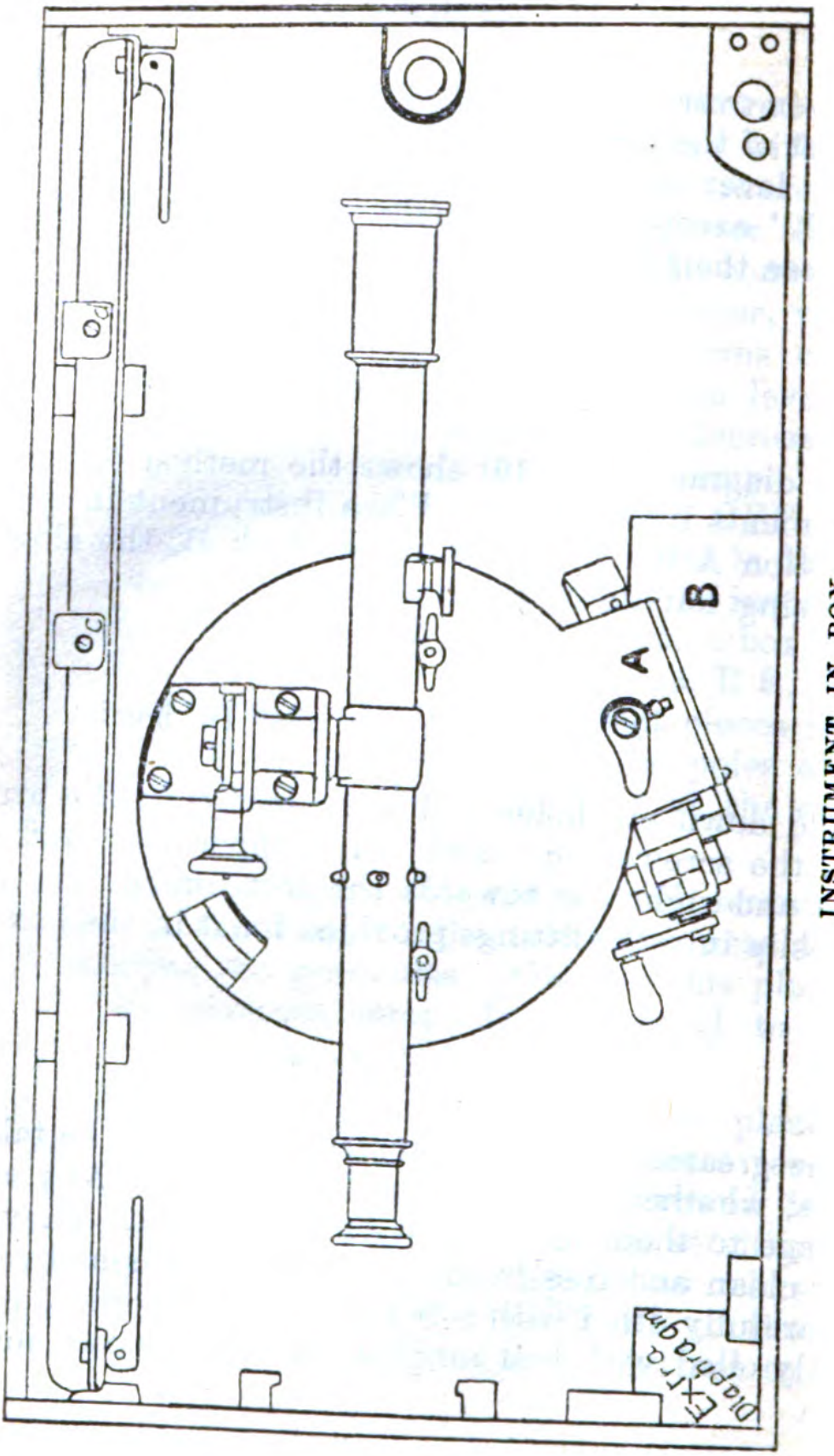

INSTRUMENT IN BOX.

FIG. 19.

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be unscrewed or removed. If requiring to be cleaned externally only chamois leather should be used to them, with as little force as possible. The removal and replacing of a diaphragm is delicate work, which should not be attempted unless the operator is thoroughly competent.

74. *The Slide Rule, Mark VI (Plate VII).*

On the face of the rule are two similar scales; one is engraved on the rule itself, the other on the slide. The upper scale is marked "yards," the scale on the slide "minutes." On the reverse side of the slide is a scale of sines. These scales are all marked off in logarithmic graduations. There is a brass screw nut, which is used for clamping the slide in any desired position. At the back of the rule are short instructions for use. If the slide is moved till the index (the 1 on the slide) is under any number on the rule, say 3, for instance, it will be seen that the numbers on the rule bear a ratio of 3 to 1 to the coinciding numbers on the slide. The numbers on the rule can thus be made to bear any ratio to the numbers on the slide by placing one number above the other, and any sum in proportion can be worked out.

The rule is, "set the 1st term of the proportion on one scale opposite to the 2nd term on the other scale, and opposite to the 3rd term on the first scale will be found the 4th term on the second scale."

A little practice is all that is necessary in reading the scale. The values depend entirely upon that given to the left-hand index of either scale, which may be any multiple or sub-multiple of 10.

The scale of sines on the reverse of the slide is used, in

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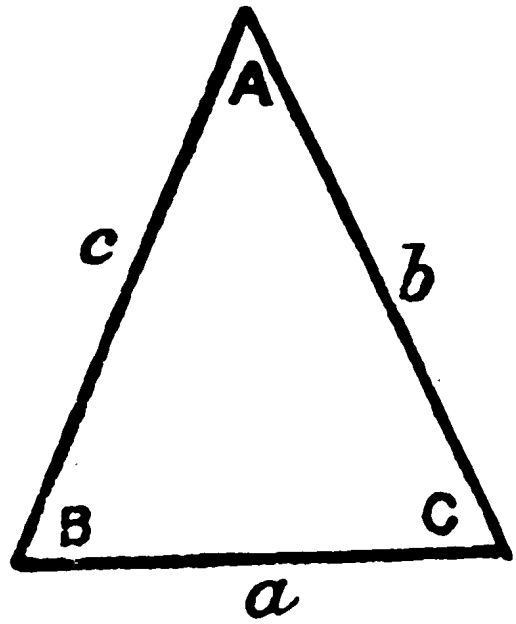
conjunction with the scale of numbers which is above it on the rule, for solving triangles.

There are two different conditions under which it may be desired to solve a triangle.

FIG. 20.



(*a*) The simplest is when one of the sides and the angles at each end of it are known. In Fig. 19 suppose the side *a* and the angles B and C are known; it is required to find the other two sides.

First of all, the angle A is found by adding B and C together, and subtracting the result from 180°.

Then, on the slide rule, set the angle A on the sine scale under the side *a* on the rule. Above the angle B will be found the side *b*, and above the angle C will be the side *c*. If either of the angles B or C is greater than 90°, subtract it from 180°, and take the sine of the remainder.

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(*b*) A triangle may also be solved, when two of its sides and the angle between them are known.

In Fig. 19, suppose the angle A and the sides *b* and *c* are known. Subtract the angle A from 180°; this gives the sum of the angles B and C.

Mark (with cursors or otherwise) on the scale of numbers on the rule above the sine scale, the sides *b* and *c*, and shift the slide about until the angles underneath the cursors or marks are together equal to the sum of the angles B and C.

Now, under the side *b* will be the angle B; under the side *c* will be the angle C; and over the angle A will be the side *a*.

If one of the angles B or C is greater than a right angle this angle must be read backwards on the slide; that is, 100° is read as 80°, 110° as 70°, 122° as 58°; and so on.

It will be found that it is not possible to read the greater angle to much accuracy, as the divisions on the slide are so small. It is, therefore, best to read the smaller angle accurately, and subtract it from the sum of the two, in order to find the degrees and minutes in the greater angle.

In the case where two sides and the included angle are known, the practical rule for working the slide rule so as to obtain accurate results quickly, is as follows :—

There are two cases.

(1) When the included angle is more than 90°. Set the exterior angle (which is equal to the two remaining angles of the triangle) under the longer side (or right hand mark on the rule), note the value of the angle under the left hand mark, shift the slide this number of degrees to the *right*, so that the reading under the right cursor is this number of degrees less than it was before; it will then be seen that

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the sum of the angles under the two cursors or marks is very nearly equal to the exterior angle and a very slight further manipulation of the slide will obtain the required result.

(2) When the included angle is less than 90°. The sine of the exterior angle (or of the sum of the other two) is then equal to sine (180°—exterior angle). Set this angle under the longer side and proceed as before, but shift the slide to the *left* instead of to the right, and remember that the angle appearing under the right hand mark is not the angle as it is read but its supplement.

Any triangle can be solved in this manner, but the more nearly equal the two given sides are, the greater will be the second movement of the slide in the final manipulation; and in the case of (2) when the sides are nearly equal, the angle under the right hand mark *is* the angle shown on the slide, and *not* its supplement.

If a field plotter is available, the slide rule is not required. It is merely an alternative means, which can be used failing the field plotter.

Formulæ.

The following formulæ for use with the slide-rule may be found useful for reference. They are arranged so that the required information is *always* found by reading *upwards*, so as to avoid as far as possible mistakes caused by reading the rule wrongly.

Siege artillery formulæ.

1. To Find the Distance Between Observers.—Put sub-tended angle, in minutes, under sub-base, in feet, and look over 1,146 for answer in yards.

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Or, put sub-tended angle in degrees and minutes (using sine scale) under sub-base in yards and over 90° on sine scale read distance between observers in yards.

The distance to the battery director is found in the same way.

2. To Find Observers' Ranges.—Put apex angle, in degrees and minutes (using the " sine " scale) under distance between observers, in yards, and look over each base angle for the *opposite* observer's range.

3. To find the Minutes in the 50 per cent. Zones.—Put the " yards due to 5 minutes " under 5, and look over the yards in the zone.

4. To Find the Minutes Deflection due to Displacement.—Put the battery range under 1,146 and look over the displacement, in feet.

5. To Find the Deflection for Difference of Level of Wheels.—Put 60 under the elevation due to range, in degrees and fractions, and look over the minutes difference of level.

6. To Convert the Observers' Observations to Battery Range.—Put the battery range under the observer's range, and look over the observation sent in in minutes.

75. *The Field Plotter. Mark III.*

Description (see *Fig.* 21).

The field plotter is an instrument designed for the mechanical solution of a triangle in which two sides and the included angle are known.

It consists of two similar bars, each having a semi-circle at one end. These bars slide on each other, and can be clamped at any point. The semi-circles are graduated in

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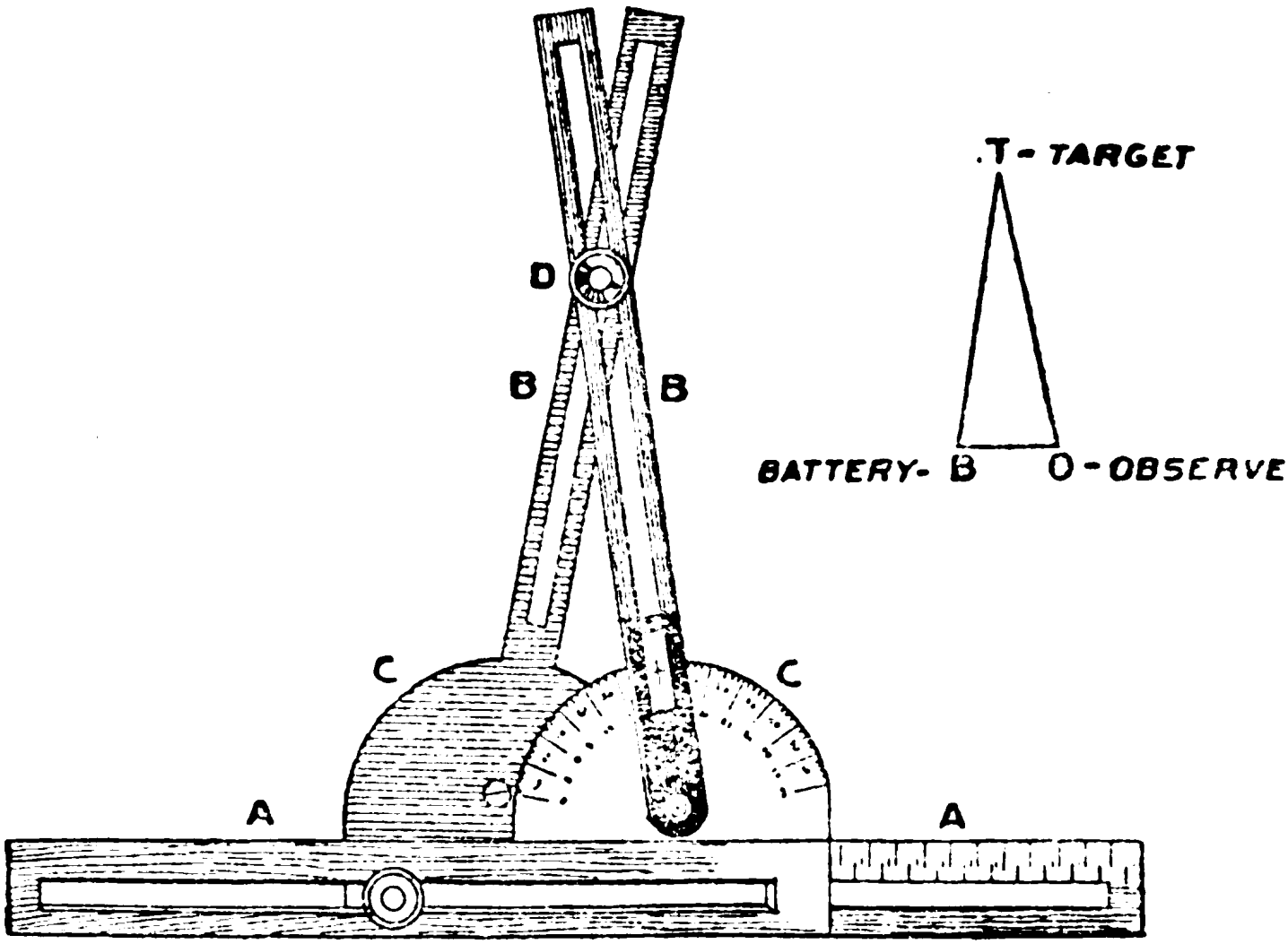
degrees, and the bars in hundreds of yards from 0 to 2,900. These graduations correspond to the distance between the centres of the semi-circles, which is known as the base. Pivoted to the centres of the semi-circles are two bars, which are joined together by a movable double clamp. The bars are graduated in hundreds of yards from 1,300 to 4,400.

FIG. 21.—FIELD PLOTTER.



NOTE.—The instrument is made of brass. A A are the base arms. B B are the range arms. C C are the arcs. D is the double clamp.

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Mark IV plotter differs from Mark III in that the base is graduated to 3,500 yards and the arms to 6,500. The arms of the Mark IV when closed are protected by the base.

Instructions for use.

The operations in using the instrument are as follows, and should be performed in the order given :—

1. Slightly loosen all clamps.
2. Set the base to the distance from the battery, B, to the observer, O.
3. Move the double clamp along the upper range arm to the distance from O to the target, T, and clamp by upper screw *only*.
4. Move the range arms till the arrow mark is opposite the angle, T, O, B, on the arc, and clamp by the *lower* screw of the double clamp. The angle, T, O, B, may be measured by means of the director (*see* instructions below).
5. Turn the instrument over, and on the range arm will be found the distance, B, T, and on the semicircle, the angle, T, B, O, which is called the "battery angle."

For longer bases than 2,900 or longer ranges than 4,400, when using the Mark III Plotter, the graduations may be taken as double yards, the angles remaining the same.

The instrument is used at the battery, in conjunction with the director, when the line of fire has to be picked up from a position a considerable distance from the battery, as in Case II of "lines of fire."

It is also used at the brigade commander's station, for directing the fire of his batteries, as explained on *pp.* 160 and 161.

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76. *The Telescope, Stand, and Director.*

Director No. 1 *with stand.*

Telescope.—The telescope is of "two draw" construction, having a field of 1° and a magnifying power of from 30 to 35. It is provided with a single sighting. wire, which can be used either vertically or horizontally (by turning the first draw of the telescope) as desired.

A small metal slide is screwed on to the body of the telescope, so as to be under the centre of gravity, when the telescope is extended, and forms a means of attaching the telescope to the stand.

Stand.—The stand consists of a tripod with round legs made of ash, surmounted by a metal head of circular form, the base of which is graduated from 0° to 180°, right and left; a circular plate is free to revolve over the base plate, and has an arrow head engraved on it, by means of which angles can be read or set off. A clamp is provided to fix the plate at any required angle. A plate of smaller diameter, formed of one piece with the pivot, and which can be fixed at will to the revolving plate (by means of a clamp), carries a slip or cradle into which the slide of the telescope fits, where it is retained by means of a flat spring.

The cradle is mounted on a knuckle joint which gives motion vertically.

For purposes of measuring angles of sight a small level (on the Abney principle) is fixed to the cradle of the stand.

The legs of the stand are jointed by means of ferrules, and are so arranged that the stand be used either with short or long legs as convenient.

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To prevent undue splay, a light chain shackles the upper portions of the legs together.

A hook is provided underneath the pivot, so that a weight may be suspended to steady the stand in rough weather.

A straight-edge sight is provided, which fits into the cradle of the stand, in a similar manner to the telescope, and can be used instead of the telescope for taking angles at short ranges.

Arrangements for transport.—For transport, the detachable portions of the legs are strapped outside the upper portion, and the whole dropped into a leather bucket, which can be attached to the saddle on the off side.

A bucket is also provided to carry the telescope in a similar manner on the near side of the saddle.

Instructions for use.

To set up the telescope and stand.—The stand is removed from the bucket, and, if it is to be used by a man standing, the lengthening portions of the legs are fixed on. In a high wind, it is recommended that the short legs be used.

To take angles conveniently, arrange the tripod so that zero is under the observer's view when he is facing the battery; or, in other words, so that 180° is towards the battery.

Extend the telescope, and slip the slide into the cradle till the spring catches.

To focus the telescope.—The telescope should now be directed on to a *distant* object, and the observer should push in the first draw tube by a slow rotary motion until he sees the object viewed, as distinctly as possible.

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Horizontal angles.—To measure horizontal angles between objects, the telescope or sight bar can be used according to circumstances, the procedure being the same.

When the telescope is used, turn the first draw tube until the sighting line in the telescope is vertical.

The revolving plate bearing the arrow head is clamped at zero by the outer clamp. The inner clamp is loosened, and the telescope directed on to one of the objects, so that the sighting line cuts the object. The inner clamp is now tightened up, taking care that the telescope does not move off the object.

The outer clamp is then loosened, and the telescope can be swung round on to the other object, the angle being read off on the graduated arc to the nearest degree.

Vertical angles or angles of sight.—Angles of sight can only be read approximately. The level is set parallel to the telescope axis when it is reading zero.

To measure an angle of sight, turn the first draw tube of the telescope till the sighting line is horizontal, and direct the telescope so that it cuts the object of which the angle of sight is required.

By means of the thumbscrew of the level bring the bubble to the centre of its run, and the angle on the small arc, read to the nearest degree, will be the angle of sight required.

The scale is marked "Elevation" and "Depression," but this is only correct when the level is on the left; if the tripod is placed so that the level is on the right, for "elevation" read "depression" and *vice versâ*.

Director No. 2 with stand.

This consists of a circular gunmetal plate, graduated in degrees, which can be revolved on its base either freely or

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by means of a wormwheel and handle fitted at one side; a drum attached to the wormwheel is graduated in intervals of 5 minutes.

The degrees are numbered from 0° to 180° on either side, marked respectively with white and black lines; in reading angles the white lines signify "Right" and the black "Left."

A telescope (magnification 15) is mounted in trunnions above the plate. Its elevation or depression up to 5° can be read on a scale by means of a clinometer level worked by a thumbscrew.

The stand is of tripod pattern, the legs being telescopic and made of steel. It is fitted with a metal head and clamping screw for attaching the director. Graticules are fitted to the telescope representing 5′, 10′, 20′, 30′, 40′, 50′, and 60′, right and left of a centre line.

Instructions for use.

Place director on stand and level instrument by the circular bubble. Focus graticules and then object glass.

Horizontal angles.—To measure horizontal angles between objects, set base plate to zero and clamp director when telescope is aligned on one of the objects. A slow motion screw has been added, enabling the telescope to be given a final adjustment on to the object. By means of wormwheel handle or thumbscrew, traverse telescope on to the other object and read off in degrees and minutes. If the angle is a large one the wormwheel handle can be thrown out of gear, and the telescope first swung round quickly in the approximate direction.

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Vertical angles or angles of sight.—The level is set parallel to the telescope axis when it is reading zero. To measure an angle or sight, direct the telescope so that the horizontal graticule cuts the object of which the angle of sight is required. By means of the thumbscrew of the level bring the bubble to the centre of its run, when the angle read in degrees and minutes (up to 58) will be the angle of sight required.

77. *The gun arc for laying off line of fire angles.*

This arc forms a temporary expedient, pending the provision of dial sights. Different patterns exist, but the following is a description of an arc suitable for the 6-inch B.L. howitzer (*see* Plate VIII) :—

An iron bar, 6 feet long, is provided with two small iron uprights fixed to it in such a position that they will fit into the foresight sockets when the bar is placed on its edge across the chase of the howitzer ; the centre of the bar (which forms the zero point) being in the position which would be occupied by the third graduation of the foresight on the right side.

The bar is graduated in half degrees outwards from the zero point, and is fitted with a sliding reader capable of being clamped in any position, and provided with a small acorn for use as a foresight, and an interchangeable V for laying back.

Use of the arc.

The arc is placed in position in the foresight sockets, and with its zero in line with the centre graduation of the tangent sight which it is intended to use.

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The reader is then clamped at the number of degrees it is required to lay off.

The gun is laid on the director, using the reader as a sight in connection with the tangent sight, which should be clamped at the centre graduation.

78. *The clinometer.*

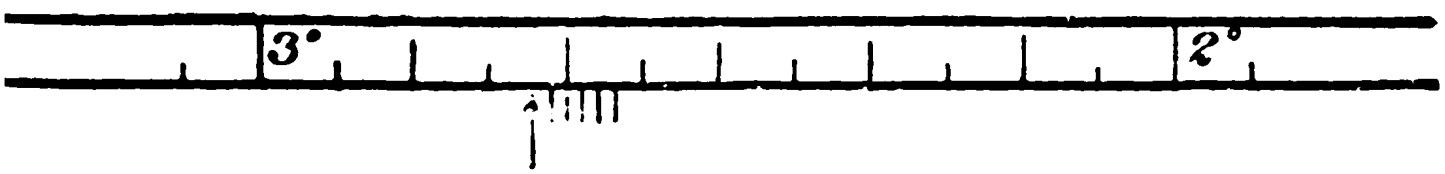
To read the angles marked on the drum.—The brass drum is marked in degrees, commencing at 0° on the top to 45° at the bottom. Each degree is sub-divided into 12 parts, each small division, therefore, represents an angle of 5 minutes.

A reader, graduated to read single minutes, is engraved on the index plate.

As the divisions on the drum vary slightly in dimensions, owing to irregularities in the cutting of the screw-thread, it will sometimes be found that the 5 minutes' graduation of the index plate does not quite coincide with a 5 minutes' division on the drum. The latter, however, having been graduated by actual testing, is to be taken as correct.

The scale is read from right to left, thus :—

FIG. 22.



The reading opposite the arrow would indicate an angle of 2° 42′.

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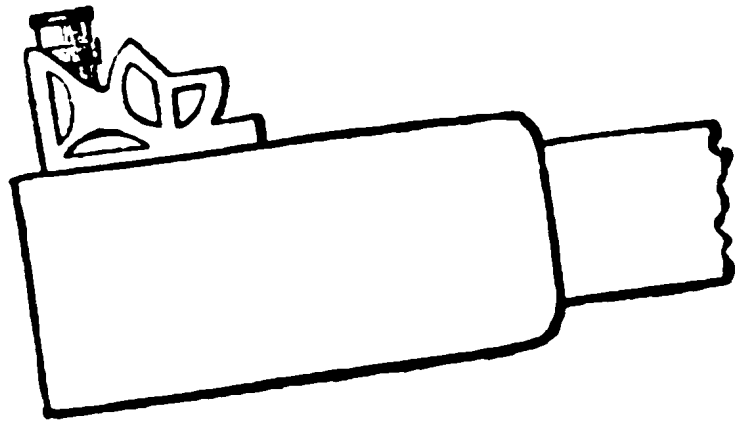
To lay a gun or howitzer at any angle up to 45°.—Unscrew the drum until the ↑ points to the elevation required, place the clinometer, thus :—

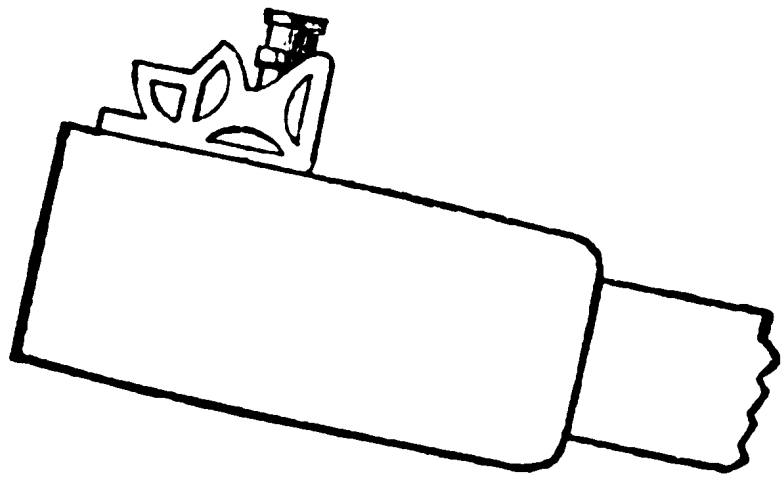
FIG. 23.



on the clinometer plane, and elevate the piece until the bubble of the spirit level is in the centre of the tube.

For angles of depression.—Proceed as above, but reverse the direction of the instrument, placing it thus on the breech of the gun : —

FIG. 24.



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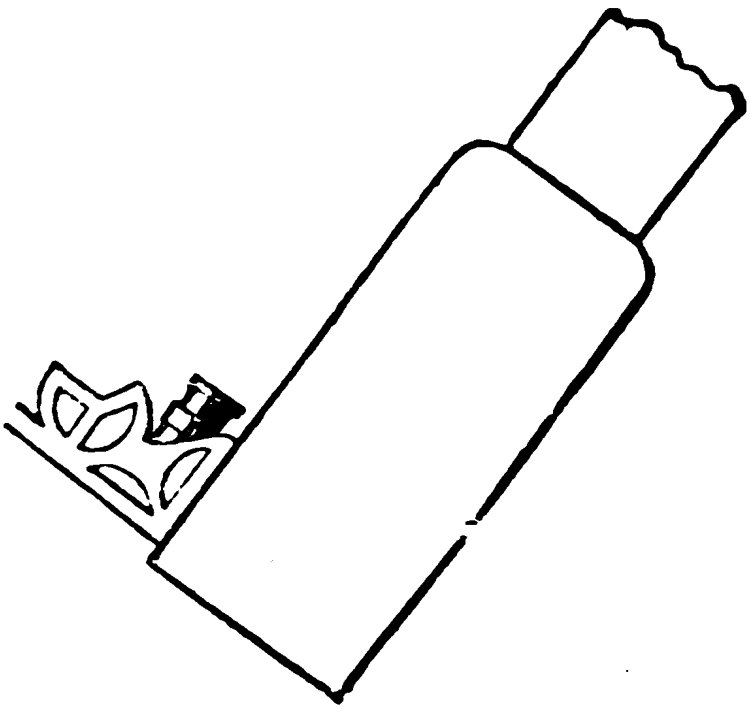
For angles of elevation greater than 45°.—Subtract the angle of elevation required from 90°, unscrew the drum to this reading; thus, for 60°, unscrew the drum to 30°, and place the instrument on the clinometer plane, thus :—

FIG. 25.



and elevate until the bubble is in the centre of its run.

(1.) In order to preserve the clinometer in efficient working order, it is necessary to keep the working parts free from grit and dust as far as possible. As excess of oil is apt to cause the adhesion of grit, only sufficient is to be applied to make the screw work smoothly, and to keep the steel parts from rusting.

(2.) On no account should the instrument be taken to pieces, as it requires special tools to put it together again.

(3.) Instruments are issued in correct adjustment, and with due care will remain correct for many years.

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(4.) To test the zero of the instrument :—

(*a*.) Carefully clean the clinometer plane.

(*b*.) Turn the drum to zero.

(*c*.) Place the instrument on the clinometer plane, drum towards breech, and elevate or depress the gun till the bubble is in the centre of its run.

(*d*.) Turn the clinometer end for end.

(*e*.) Should the bubble not return to the centre, the instrument is out of adjustment.

(*f*.) As the amount of the error will generally be small, it is advisable to add or subtract the error, as the case may be, rather than correct the adjustment.

(*g*.) To ascertain the error after complying with (*d*), drum towards muzzle, turn the drum until the bubble is again in the centre of its run; *one-half* the reading on the drum is the index error; what is practically a new zero point on the scale is thus determined.

(*h*.) If the reading falls on the part graduated in black on the scale, *add the index error* when setting the clinometer for any required *elevation*; subtract the index error when taking a reading with the clinometer.

(*i*.) If the reading falls on the portion graduated in red on the drum, *subtract the index error* for any required *elevation*; add it when taking a reading.

(5.) If it is required to adjust the clinometer to have *no* index error, set the drum to the ascertained index error, and bring the bubble to the centre of its run by elevating or depressing the gun. Then, placing the drum at zero, manipulate the capstan-headed nuts (using a tempered steel wire just fitting the holes in the nuts) till the bubble is in the centre.

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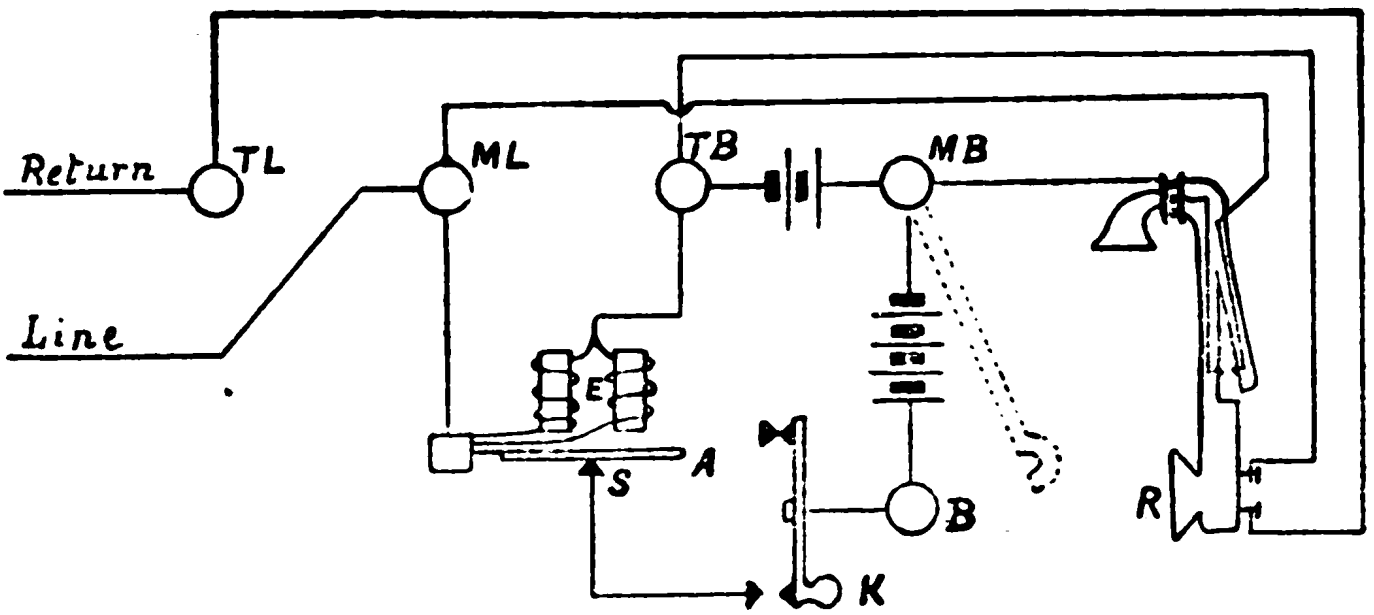
Reversing the instrument end for end should not alter the central position of the bubble; should it do so proceed as before until there is no change.

In giving elevation by clinometer, great care should be taken that the clinometer plane is clean and free from paint, grit, &c., that the instrument is placed in the same position every round, that it is correctly set by the graduated scale and the elevation adjusted so that the air bubble may be in the same place each round, *always finishing off with depression*. The layer's eye should be in the same position relative to the clinometer for each round.

When *laying* with the clinometer, it is convenient (as mentioned in *p.* 38) to get one end of the bubble tangential to a line on the glass, being careful to always use the same line; but when ascertaining the index error, or adjusting a clinometer, the bubble must be brought to the true centre.

79. *The Vibrating Transmitter (Mark III) with telephonic connection.*



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The vibrating transmitter consists of an electro-magnet, E, a contact screw, S, an ordinary Morse key, K, and terminals, mounted on a wooden base.

The armature, A, of the electro-magnet is made of a strip of soft iron or steel. The connections are so arranged that, on the key K being depressed, the battery current is sent through the electro-magnet, and the contact made by the screw S on the armature. The armature is at once attracted, but, as soon as it moves, it breaks the circuit at the screw contact. The magnetism is then lost, and the armature falls back into contact again; thus producing a vibration.

One of the line wires is connected to TL and thence the connection goes through the receiver R and terminal TB to one end of the magnet coils; the other line wire is connected to ML to which terminal the other end of magnet coils is connected, thus, each impulse of current through the electro-magnet is also sent to line, the two being in divided circuit; and the impulses of the current on the line have the same frequency as those through the electro-magnet, and, when received in the receiver R, cause the diaphragm to vibrate to a similar note to that of the armature.

The electro-magnet E, is wound to a resistance of about 10 ohms; hence the current through it is practically independent of the resistance of the line.

The action of the electro-magnet, on account of its self-induction, increases the strength of signal on the line; for, when the current starts through the magnet, there is produced in it an opposing E.M.F., which increases the strength of current on the line; and when, by the armature leaving the contact, the battery current is broken, there is produced an E.M.F. which acts in the same direction as that of the battery did.

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The vibration signals are received in the Receiver R, of an "Operator's Telephone," which is inserted in the line, and not (as in ordinary Morse instruments) on the back contact of the key K; the reason of this being, that the receiver of the sending station should act the part of a galvanometer, and indicate whether the current is going to line.

This "Telephone, Operator's" is attached for use, when speech is resorted to.

When the microphone switch (see to the right of diagram) is pressed, it is brought into circuit with the coils of the electro-magnet and a part of the battery.

When the microphone is spoken into, the variations in its resistance affect the current through the coils of the electro-magnet, which acts as an induction coil in an ordinary telephone circuit; the re-action of the magnetic changes also affecting the line signals.

The circuit through the microphone does not, of course, pass through the contact S. This circuit is completed by means of a switch in the handle of the operator's telephone, which is pressed by the hand when speaking. This pressure may be released when listening, thus saving the battery power; but, if found more convenient, the pressure may be kept on during the whole time of conversation.

Attention is called for speaking by means of the vibration signals, which are sent by working the vibrator key K, as usual.

The microphone switch should not be closed when working with the vibrator key.

Only two cells should be employed for speaking purposes.

The terminals attached to the instrument are marked with the initial letters of the apparatus to which they should be connected; two leads being joined to each terminal.

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The only adjustment necessary is that the armature should vibrate freely when the key is depressed; and the contact screw S should be set so as to produce this result. When set, it must be finally clamped.

The terminal B, on the right hand side of the key K, is in connection with the bridge of the key, and a link connects it to the terminal MB; so that the same battery can be used for the vibrating signals as for the microphone; but, should it become necessary to increase the power on the vibrator above what is suitable for the microphone, the extra cells can be connected between MB and B, and the link between them removed (as in the diagram). Of course, this battery must be joined *in series* with that between TB and MB.

To test the instrument.

When joined up, remove one of the line wires; depress key K, and no sounds should be heard in the receiver; or, if heard, they should be, at most, very faint. This certifies that the instrument is not short-circuited.

Next, connect terminals TL and ML by a piece of wire, or the blade of a knife; on pressing key K loud sounds should be heard in the receiver.

To test the microphone.

Join terminals TL and ML by a piece of wire; close the microphone switch, and with the tip of the finger gently rub the interior of the mouthpiece of the microphone; these sounds should be heard in the receiver; if not heard, the instrument is at fault.

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Great care should be taken to see that the rings of the receiver are in their places, and that the receiver cup is not screwed on too tightly.

When speaking, the telephonic signals can be improved by slightly shaking the microphone now and again. This does not mean beating it violently on the ground.

When issued, the ends of the microphone leads of the "Operator's Telephone A" are frapped with red cotton or silk to facilitate identification, and the conducting wires are tinned copper. If they cannot be identified in this manner, find the receiver leads by making contact with the poles of a cell, until two leads are found which give guttural sounds in the receiver, these should be attached to the terminals TL and TB, the other two leads being attached to terminals ML and MB.

The battery used with this instrument is "Battery Leclanche," H, 6 cell, Mark I, which is to be replaced by the Battery Obach dry, "O," 6 cell, Mark I, *see* List of Changes, 12816.

Only two cells should be used for the microphone circuit, and the six cells for the vibrator. The brass strap between MB and B (shown in dotted lines) must be disconnected when using the battery as above, or the cells between MB and B will be short-circuited.

Telephone sets, portable 'C,' Mk. I.

It consists of a box containing two dry cells ('P') type, a magneto generator, polarised bell, induction coil, testing plug, and a Hand Telephone 'C,' Mk. I. The cells are joined in series, and fit one in each corner at the back of

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the box. The hand telephone fits on a rest, when not in use. If differs from the Hand Telephone A (which is used with Transmitting Vibrator, Mk. IV) by the pressel switch having an up and down contact, that is, it makes a contact in the released as well as the pressed position, thus doing away with a special switch for the bell or call circuit, as this circuit passes through the switch when it is in the up or released position.

The generator handle and testing plug are carried, when not in use, by holders in the lid. The telephone is also provided with three terminals, two for the line wires and one for the earth connection. Between the line terminals is fitted a common form of lightning discharger.

Rough tests.

(*a*) *To test the ball circuit.*—Turn handle of generator with line wire disconnected; bell should not ring. Insert plug between the two small brass strips of the lightning discharger (or connect line terminals), and repeat; the bell should now ring loudly.

(*b*) *To test speaking circuits.*—(1) Place receiver of telephone to ear, close pressel switch; on blowing into microphone no sounds should be heard. (2) Insert plug between brass strips, and repeat; sounds should now be heard distinctly in receiver.

Tests in detail.—If the bell fails to ring, it may be due to a mechanical fault at the generator switch as the rubbing contact not touching the armature, or the bell armature may be out of adjustment. To put either of these mechanical faults right, it will be necessary to open the

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central partition of the instrument, by disconnecting the battery wires at Z and K, and then removing the holding down screws. As the top is a neat fit it will require careful handling. If sounds are heard in receiver when applying the first portion of test (*b*) the line terminals are in some way short-circuited. If second portion fails it will prove a fault in either the primary or secondary circuit, or perhaps both.

To test the primary circuit for continuity, connect a current detector (low resistance coil) in series with it at any convenient point, say at battery; close pressel switch, when a deflection should be obtained in detector. If not, look carefully to the battery connections by removing the metal covers from the cell boxes, and then test each cell by connecting the detector (low resistance coil) between the positive and negative of each when a hard over deflection should be obtained; if not, the battery should be replaced by a new one. If the fault has not been detected, tap the microphone gently, as the carbons may have packed a little. If still undetected, trace out circuit carefully with a battery and detector in series. To test secondary circuit, join a two-cell battery and detector (high resistance coil) in series with the line terminals, plug should not be inserted. When the pressel switch is closed a deflection should be obtained in detector. A deflection is also obtained when this switch is released; the current in this case flows round the bell circuit. It is the deflection when the switch is pressed that is wanted. If this is not obtained short circuit the terminals 3 and 4 by a piece of wire or metal of any kind; if a deflection is now obtained, it proves the fault is in the receiver or leads. Repeat by short circuiting on terminals on back of receiver; if no deflection, it proves a break in receiver leads.

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If there is a deflection, it proves a break inside receiver. If a fault is still on, open the middle partition and trace out circuit carefully.

Telephone sets, portable, 'C,' Mk. II.

It consists of a case with a lid at each end, one fixed with a simple hook gives access to the hand telephone, handle of generator, &c., and is for the use of the operator; the other, fixed with screws, gives convenience for testing the internal connections. The generator, bell and induction coil are connected to a tray which fits in grooves in the side of the case and can be taken out when required. Hand Telephone 'C,' Mk. II, forms part of the set, and two dry cells (P type) are used.

The generator has four magnets, and the armature is wound to a resistance of 700 ohms. It is capable of ringing its own bell through a resistance of 12,000 ohms and is provided with a cut out which leaves the generator disconnected when at rest. When the handle is turned the spindle revolves freely inside the driving wheel until a pin on it engages in a V-shaped slot in a washer fixed to the driving wheel; the spindle then moves to the left and causes the driving wheel to rotate, at the same time completing the circuit by closing a spring contact at the other end.

The bell is of the pivoted armature type, and is wound to a resistance of 1,000 ohms.

The generator and bell are in parallel with the line terminals. One end of the secondary speaking circuit is connected to line 2, the other to the switch in the hand telephone, and is disconnected when the switch is not

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pressed. When the switch is pressed, it also puts the primary circuit to line 1; the other end of the primary is permanently connected to line 1. The lead of the hand telephone marked M. 2 is not required for use with this instrument, and is therefore connected to a dummy terminal.

Two lightning dischargers are provided, a serrated plate protector, and a " Discharger " lightning bobbin on each line. Two spare bobbins are also carried.

Tests.

1. *To test bell circuit.*—Disconnect line wires, turn handle of generator, bell should ring, short circuit line terminals, bell should not ring.

2. *To test speaking circuit.*—Disconnect line wires, close pressel switch, taking care that it is pressed well home, blow into transmitter, sound should be heard faintly, short circuit line terminals, sound should be distinctly heard.

If (2) fails, (*a*) Test primary circuit by breaking at M. 1 and inserting low resistance coil of a detector, there should be a deflection only when pressel switch is closed. (*b*) To test secondary circuit, place a battery and detector (high resistance coil) in series with line terminals, disconnect M. 1, close pressel switch and there should be a good deflection, and only a slight deflection when switch is released.

If either of these tests fail proceed as previously detailed.

NOTE.—There is a double contact in pressel switch, the first contact closes secondary and second closes the primary. In testing the primary circuit care should be taken to see that the secondary contact is made.

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To remove tray from box, remove back and disconnect M^1, R^1, and R^2, remove the terminals to which lightning protectors are joined, also handle of generator. The tray should then slide out easily.

80. *Telescope variable power, Mark I.*

The Telescope No. 1 is of the erecting type and is provided with a revolving collar at the eyepiece of the telescope; this, on being turned, alters the magnification from 7 to 21 diameters without throwing the telescope out of focus. It is fitted with graticules spaced so that they show the following angles:—1 minute, 10 minutes, 30 minutes, 60 minutes, 90 minutes, on either side of the axis of the telescope.

The Telescope No. 2 is similar to No. 1, but has no graticules. The best effect of a variable power telescope is obtained by trying it at all powers and seeing when the object is most distinct.

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APPENDIX II.

Destruction of Guns and Blind Shell.

81. *Destruction of guns.*

B.L. guns can easily be temporarily disabled by removing the breech block, or by damaging the breech mechanism or the screw threads with a crowbar or a heavy hammer; the sights should also be removed.

Their permanent destruction can best be effected by means of guncotton, as follows :—

(1) A shell having been loaded in the ordinary way, the necessary charge is packed in behind it, so as to be in close contact with the shell and with the sides of the chamber.

(2) The primer is next inserted in the guncotton slab.

(3) Sods, earth or other material are then used to keep the guncotton in position.

(4) The detonator, with the safety fuse or electric leads attached, is placed in the primer.

(5) The breech block is swung to as far as the safety fuse or electric leads will allow.

(6) The charge is then fired.

The charge required is given by the following rule :—For a 3-inch gun use 2 lbs., and double the charge for every inch increase in calibre :—*e.g.*, for a 4-inch gun use 4 lbs., and for a 5-inch gun 8 lbs.

It is not absolutely necessary to use a shell, but the effect of the explosion is thereby increased.

Other high explosives may be used instead of guncotton, but in some cases special precautions have to be taken—*e.g.*, dynamite is often frozen, and must be carefully and slowly thawed before being used.

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Guncotton slabs are usually about 6 inches square, and weigh either 1¾ lbs. or 1½ lbs. Cavalry pioneers carry 1 lb. slabs. Slabs are kept wet.

Guncotton primers are cylindrical in shape, and are of two sizes weighing 1 oz. and 2 oz. respectively. They are dry.

It is difficult to detonate wet guncotton by itself. A primer is easily detonated. To detonate a charge of wet guncotton a primer is put in close contact with the wet slabs. The primer is detonated, and this causes the wet guncotton to detonate also.

There are two kinds of detonators in the service for detonating guncotton :—

(1) Detonator No. 8 for safety fuze.
(2) Detonator No. 13 for use with electrical firing apparatus.

The No. 8 detonator consists of a brass tube, painted red. The smaller end contains fulminate of mercury. The larger end is hollow, and is covered by a paper cap.

Safety fuze is painted black, and carried in tin cylinders, and will burn under water. The usual rate of burning is 3 to 4 feet per minute, but if it has been kept in store long, especially in a tropical climate, it may burn much quicker and a piece should be tested.

To prepare a charge to be fired by No. 8 detonator :—

(1) See that the guncotton slabs are in close contact with each other, and that the primer is properly inserted in and touching a slab.
(2) Take a piece of safety fuze of such length that the man lighting it may have time to get to a safe distance before the charge is detonated. Cut one end square and the other on the slant.

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(3) Remove the paper cap from the end of the detonator.

(4) Insert the square end of the safety fuze and press it gently in, taking care not to touch the smaller end of the detonator. Then pinch or bend the larger end to prevent the fuze being pulled out.

(5) Insert the smaller end of the detonator gently into the hole in the primer. If this is too small enlarge it with the rectifier—a boxwood implement supplied for the purpose. If it is too large, wrap a piece of paper round the detonator to make it fit tight.

(6) Light the slanting end of the fuze. A fusee or portfire is more convenient than an ordinary match.

To fire a charge electrically, the primer and slabs are arranged as already described. The No. 13 detonator is connected to the leads and is then inserted in the primer, and is fired by an "exploder." Care must be taken that the other ends of the leads are not attached to the exploder till everything is ready for firing.

Heavy M.L. guns can be destroyed with charges of 4 lbs. of guncotton placed at the bottom of the bore and well tamped with water or sand. The charges can be fired electrically or with No. 8 detonators, but if water be used, the charge must be enclosed in a waterproof bag to keep the primer dry, and further, if electric leads are used, the joints should be carefully insulated with india-rubber tape and solution.

82. *Destruction of blind shell.*

The destruction of blind shells with guncotton will only be carried out under the superintendence of an officer.

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In order to limit, as far as practicable, the possible projection of fragments of shells which are submitted to this treatment the shell to be operated on should, in the first place, be entrenched on all sides by throwing up the adjacent earth, sand or fine shingle round it to a height at least double that of the shell. Wet guncotton is placed (and if necessary tied) on the shell in 15 oz. slabs, the number necessary varying with the size of the shell. It is essential, if more than 1 slab is used, that the slabs should be touching one another. A dry guncotton primer, the hole in which should be eased if necessary with a rectifier to take the electric detonator, is inserted in the hole in the charge of wet guncotton.

The electric detonator, coupled up with the connecting wires leading to an exploder, but disconnected from it, is then inserted in the dry primer.

The bare portions of the connections of the wires with the detonator must be carefully kept from contact with each other and with the earth.

When these preparations are complete, and the operators and all persons present have retired under cover, the conducting wires are connected with the dynamo-exploder and the charge is detonated. When no cover is available the following are the minimum distances from the burst within which any person should be allowed to approach :—

Shrapnel 18-pr. and under	... ...	300 yards.
„ above 18-pr. to 6″	... ...	500 „
Common shell under 4·7″	... ...	500 „
„ „ 4·7″ to 6″	... ...	800 „
Lyddite shell 4″	... ...	1,200 „
4·7″ and 5″	... ...	1,500 „
6″	... ...	1,800 „

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APPENDIX III.

Tests for Specialists.

The examination in the following tests will be carried out by a board of company officers, one of whom should be the major or captain.

83. *Tests for layers.*

There will be two tests; (a) a test with the cross bar sights, and (b) a test with the dial sight.

Test (a).

For the examination in this test a 6-inch B.L. howitzer on a double-decked platform will be used. (The trunnions must be approximately level.)

Each layer will lay three times. The director will be moved about 2 yards right or left to a fresh position for each round.

The howitzer will be placed with approximately no elevation. Sights unclamped all over. The layer will be told to chalk the necessary headings on the howitzer, and to set the sights at zero of deflection and the sliding leaves at the centre graduation. The director as laying back point will be pointed out, and the deflection will be given to the layer and chalked on the howitzer; additional deflection, as for difference in level of wheels, will then be given.

The board will satisfy themselves as to the correctness of these details, and that the various headings are clearly filled

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in. The word "Lay" being given, Nos. 2 and 3 will stand to traverse, and 5 to elevate. The layer will step in, and—

i. Lay on the director.

ii. Select an auxiliary mark and shift sights on to it, note its description on the howitzer and the readings of the sliding leaves.

N.B.—The picket in line with the auxiliary mark may be omitted in this test.

iii. Put on the deflection and lay on the auxiliary mark, trail plank being properly adjusted.

iv. Remove tangent sight.

Time to be taken from "lay" to the removal of sight.

The whole operation to be watched by the board, and any mistakes noted. Special attention should be paid to the correct and exact description of the auxiliary mark, and to the part of it selected to lay on.

Any grave error which would result in a round being thrown away will forfeit all marks.

Each slight mistake will forfeit 1 mark. The board will check the laying for line. If the amount of deflection put on, the readings of the crossbars, and the laying for direction are each correct within 1′, R. or L., no marks will be deducted. For every error of one minute in excess 1 mark will be deducted.

The sliding leaves will then be clamped at the centre graduation as before, and the laying on the director checked. If correct within 1, R. or L., no marks will be deducted. For every error of one minute in excess 1 mark will be deducted.

An error in excess of 3 minutes, in a horizontal direction,

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whether caused in setting the sights or in laying, will disqualify for that particular round.

Full marks for each round 20
Time limit ..... 2 minutes.

For every 10 seconds or fraction of 10 seconds in excess of 2 minutes deduct ½ mark. To "qualify," each layer must obtain 50 marks for the 3 rounds.

Note.—Before layers are examined as above, the officer commanding the company must satisfy himself that they are capable of laying a howitzer by the direct method.

Test (b).

A 6-inch howitzer being placed on hard but unlevel ground, and with approximately no elevation, the dial sight is placed in the bracket with the elevation, deflection and small drums at zero, and the base plate unclamped.

The angle to director is called out to the layer in degrees and minutes, and the layer writes the angle on the gun. The deflection is then called out, and the layer writes this on the gun also. As soon as the layer is ready the order "go on" will be given.

The layer then :—

(*a*) Sets the sight at the director angle; whole degrees on the base plate, and minutes on the small drum.

(*b*) Lays on the director, attending to the level of wheels. The layer then gives "take post," and the board checks :—

(1) The line to the director.
(2) The level of wheels.
(3) The reading on the base plate.
(4) The reading on the small drum.

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As soon as the layer is again ready, the order " go on " will be given.

The layer then :—

(*c*) Picks up an auxiliary mark, with the base plate at the whole number of degrees and the minutes on the small drum.

The layer then gives " take post," and the board checks :—

(5) The line to the auxiliary mark.
(6) The reading on the base plate.
(7) The reading on the small drum.

As soon as the layer is again ready, the order " go on " will be given.

The layer then :—

(*d*) Puts on the deflection.
(*e*) Lays the gun on the auxiliary mark, attending to the level of wheels.

He then gives " take post."

The time is taken from " go on " to " take post " on each occasion. Total time allowed 2¼ minutes; for every 10 seconds, or fraction of 10 seconds over 2¼ minutes, ½ mark to be deducted.

The board then checks :—

(8) The line to the auxiliary mark.
(9) The level of wheels.
(10) The reading of the deflection drum.

For readings (2), (4), (5), (7), (8), (9), and (10) no marks will be deducted for errors up to and including 1′. For every minute or fraction of a minute over 1, 1 mark will be deducted. If there is any error of 4′, or more, no marks will be given for the test. For readings (1), (3) and

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(6) no marks will be deducted for errors up to and including 3′. For every minute or fraction of a minute over 3′, 1 mark will be deducted. If there is any error of 6′ or more, no marks will be given for the test.

Each layer lays 3 rounds.

Full marks for each round, 10.

To " qualify," each layer must obtain 22 marks.

Every layer will be examined to see if he understands :—

(*a*) Care of the telescope.

(*b*) How to focus the telescope.

(*c*) The tests for sighting gear and sights, as detailed in the Handbook of the gun.

84. *Tests for observers.*

All the observers will be tested by the tests under the heading (1) below. *At least two per half company* will be tested by the tests under the heading (2) in addition to (1). *At least two per half company* will be tested by the tests under the heading (3) in addition to (1). *All* observers who are *not* tested by the tests under the headings *either* (2) *or* (3), will be tested by the tests under the heading (4), in addition to (1).

(1) All the observers will be tested in the following duties :—

(*a*) Setting up the observation of fire instrument, and the use of the various parts and adjuncts of it.

(*b*) Laying at zero on natural objects, measuring horizontal angles and sub-bases, and taking angles of sight.

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(*c*) Picking up and clamping on the flash of cordite puffs at night, and observing the flash of powder puffs, representing shell bursts, both by day and night.

For this test the examiner will be provided with a separate instrument placed close to the one being used by the observer.

(*d*) Converting observers' results to battery range, by means of the slide-rule, and combining the results of two observers to obtain the alteration of apex angle.

The above tests will be carried out practically by the board, and each observer will be recorded as "qualified" or "not qualified," according to the opinion of the board.

To obtain Class I proficiency pay, an observer must be recorded as "qualified" in each of the tests (*a*) to (*d*), and also in the tests laid down in *either* (2), (3) *or* (4).

(2) Tests for "Line of Fire" observers.

At least two observers from each half-company will, in addition to the tests in (1), be trained and tested in the duties of laying out the line of fire.

For this test the observers will be required to :—

(*a*) Set up a director in a line indicated by the board, in rear of a battery of four howitzers. Lay the director on the target. Lay on each howitzer in succession, read off, write down and report to the howitzers the angle for each. Pace and note down the displacement of each howitzer from the battery commander's line.

(*b*) Carry out the same duties as in (*a*) but with the director in front of the battery.

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(*c*) Find the battery angle and range by means of the field-plotter, from data supplied by the board. Set up the director in rear of the battery, and lay it on the flank director at the battery angle. Lay the battery director in the zero line to the target.

For this test a director, or mark representing one, will be placed a considerable distance to a flank; and the board will give the observer the base, angle, and range from the flank director.

(*d*), (*e*), and (*f*) The same tests will be repeated, using an observation of fire instrument as director.

According as the observers show themselves reasonably proficient or otherwise, in the *whole* of the above headings (*a*) to (*f*), the board will record them as "qualified," or otherwise, in "line of fire" duties.

(3) Tests for "Range-taking" observers.

At least two observers from each half-company will, in addition to the tests in (1), be trained and tested as range-takers.

The tests for these will be as follows, the ranges to the objects selected being previously taken by the board, by means of observation of fire instruments with a big base:—

(*a*) A well-defined object at about, but not less than, 2,000 yards range will be pointed out, and the order given to "go on." The range-taker, working with the assistance of a No. 2, will then take the range, and as soon as he has finished will report "range taken," and at once call out the range.

Time will be taken from "go on" to "range taken." The time allowed will be 3 minutes, and the error in range 50 yards. For every 10 seconds, or fraction of 10 seconds over 3 minutes, 1 mark

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will be deducted:—and for every 10 yards, or fraction of 10 yards over 50 yards error, 1 mark will be deducted. Full marks—10.

(*b*) A less well-defined object at a range of about, but not less than 3,000 yards will be pointed out, and the range taken as before.

Time allowed, 5 minutes. Error allowed, 100 yards. For every 20 seconds, or fraction of 20 seconds, over 5 minutes, deduct 1 mark. For every 25 yards, or fraction of 25 yards error over 100 yards, deduct 1 mark. Full marks—10.

(*c*) A moderately difficult object at a range of about but not less than, 4,000 yards will be pointed out, and the range-taker told to take the range to it, working in double yards. Time will be taken as before.

Time allowed, 6 minutes. Error allowed, 100 yards. For every 20 seconds, or fraction of 20 seconds over 6 minutes, deduct 1 mark. For every 25 yards, or fraction of 25 yards error over 100 yards, deduct 1 mark. Full marks—10.

To "qualify," a range-taker must obtain a total of 20 marks for the three tests. The board will also ascertain that the range-taker understands the construction of the instrument, and is able to take a range without the assistance of a No. 2.

(4) Tests for observers, other than "line of fire" or "range-taking" observers.

All observers who are not trained and tested in either "line of fire" duties, or in "range-taking," must, in addition to the tests in (1), be trained and tested in semaphore signalling.

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They will not be required to pass the tests laid down in the Manual of Signalling, but to be recorded as "qualified" they must be able to send and read at the rate of six words a minute.

85. *Tests for telephonists.*

The examination will be a practical one, carried out in accordance with the following tests :—

Telephonists must be able to :—

1. Send and receive twelve words a minute with the vibrator transmitter.
2. Connect up and test the vibrator transmitter (30 marks).
3. Transmit messages and test the portable telephone (20 marks).
4. Lay out lines and carry out simple line tests (30 marks).
5. Understand the care and preservation of apparatus in use (20 marks).

To pass, 60 marks must be obtained in tests 2 to 5. Telephonists will not be examined in tests 2 to 5 until they have passed in test 1.

In addition, before being recorded as "qualified," all telephonists must be able to signal with the flag, lamp, and heliograph, by means of the Morse code, at a minimum rate for sending and reading in each case, at eight words a minute, and with flags, by the Semaphore system, at ten words a minute.

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86. *Tests for fuze-setters.*

At least six men from each section, exclusive of serjeants, will be examined at fuze-setting. The following test is laid down for guidance :—

At the order "Fuze . . . set," five shells are fuzed and the fuzes set at the graduation ordered.

As soon as finished the competitor will say "take post," and step clear.

The time will be taken from "set" to "take post," and to obtain full marks must be 2 minutes or under.

Two marks will be deducted for every 5 seconds or fraction of 5 seconds over this time, and five marks for any fuze incorrectly set, not tightly clamped, or not tightly screwed home in the shell.

Full marks, 10. To "qualify," six marks must be obtained.

This test also forms part of the practical examination for classification as first-class gunner when qualifying for Class II proficiency pay.

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PLATFORM, SIEGE, DOUBLE DECKED MARK II.

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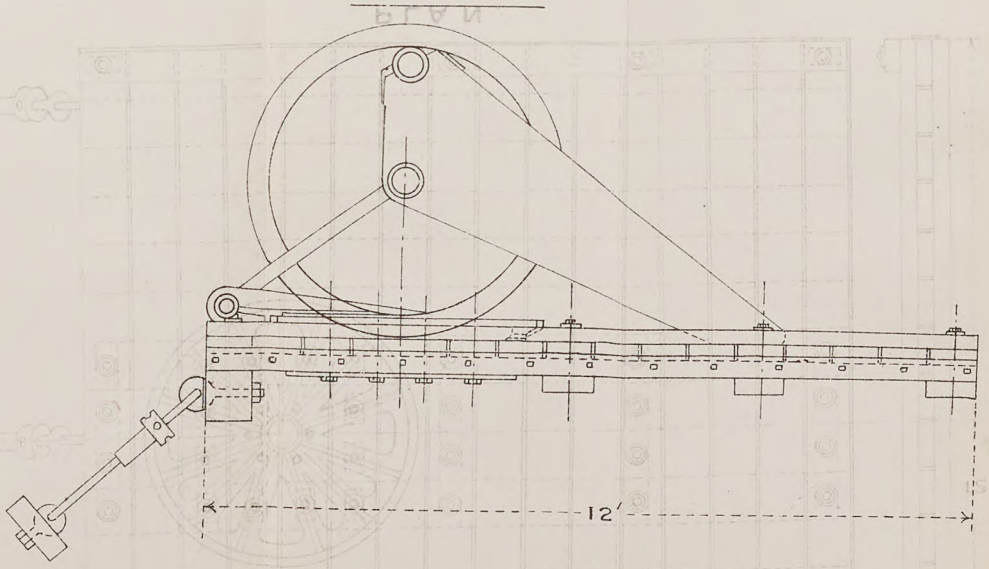

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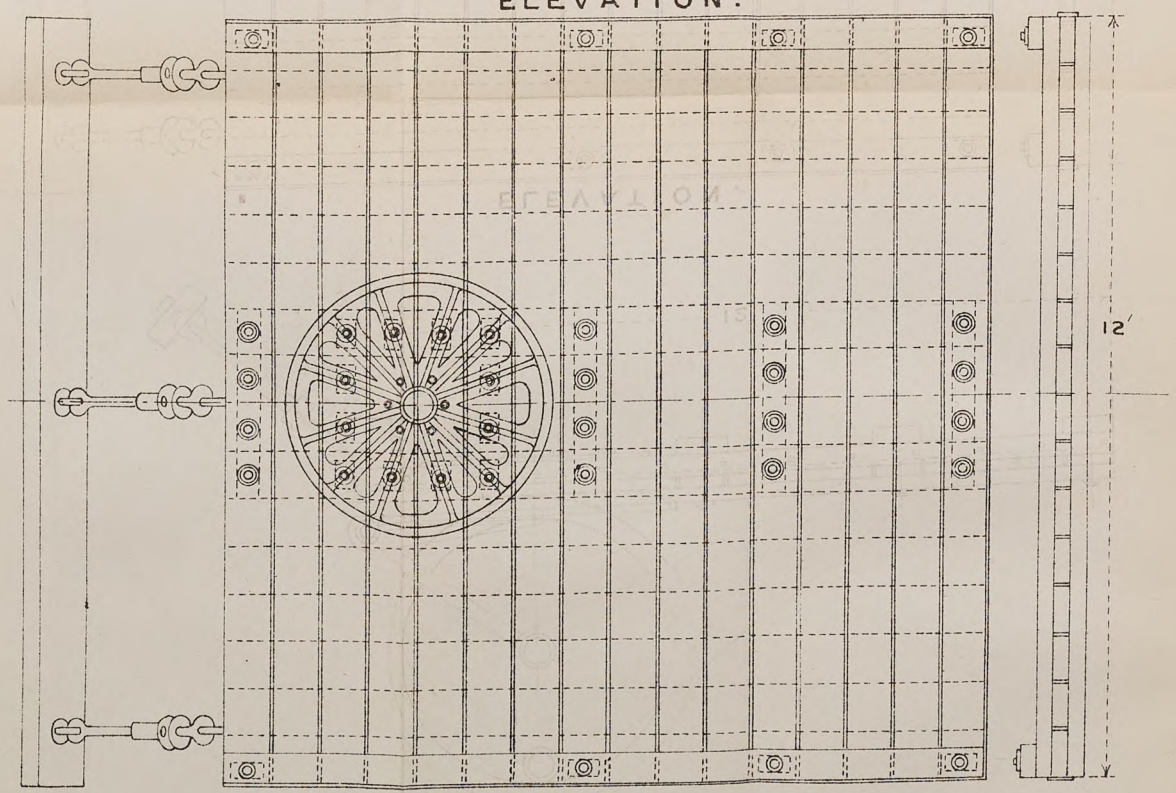

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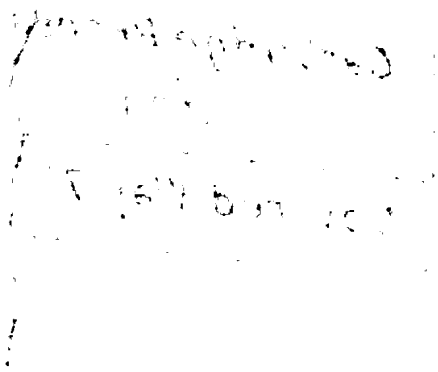

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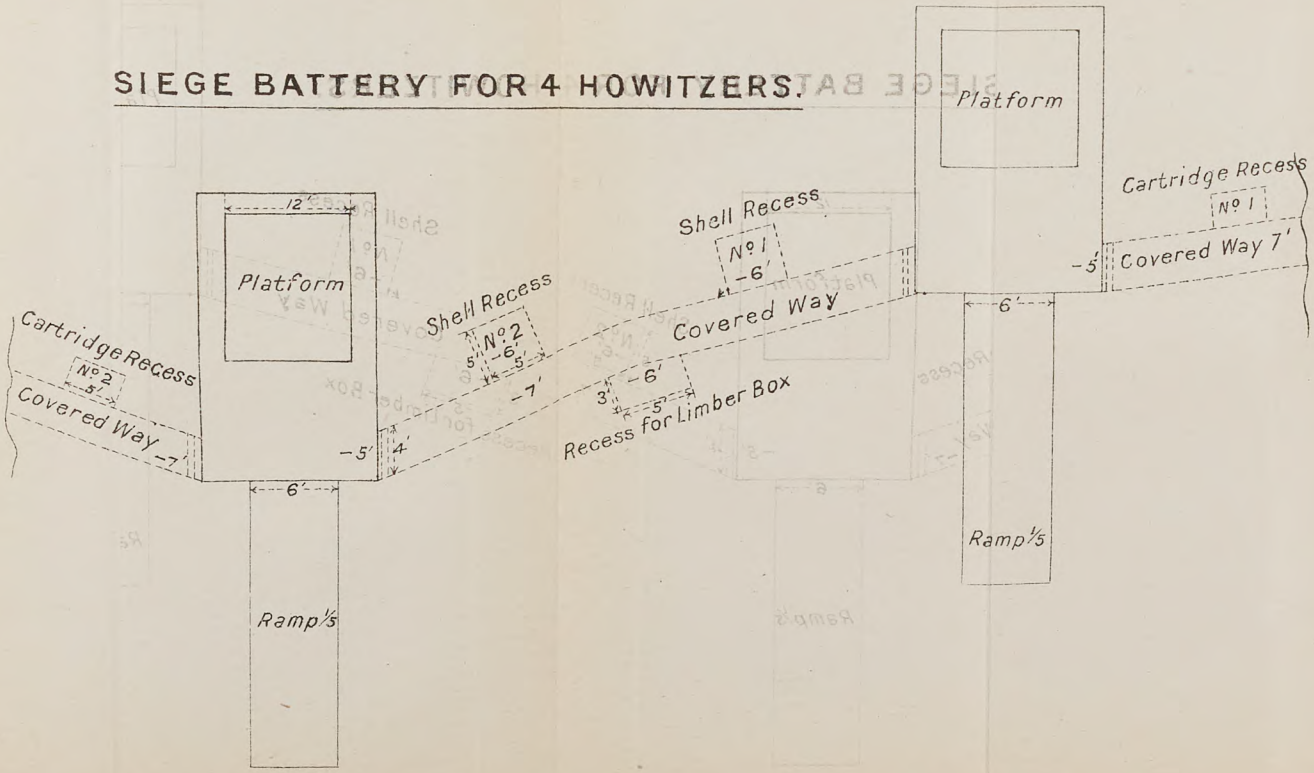
SIEGE BATTERY FOR 4 HOWITZERS.



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PLAN OF A SIEGE BATTERY.

RIGHT HALF.

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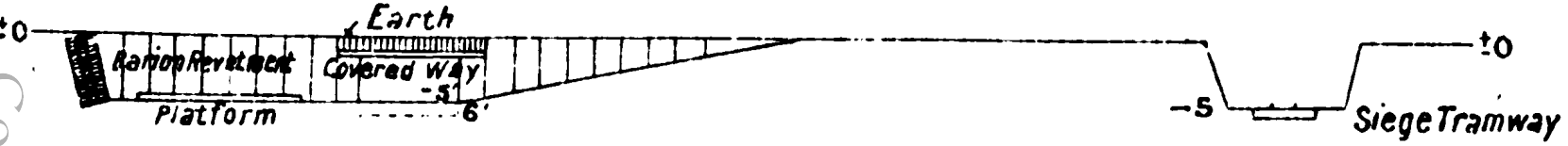
SECTION AT A.B.



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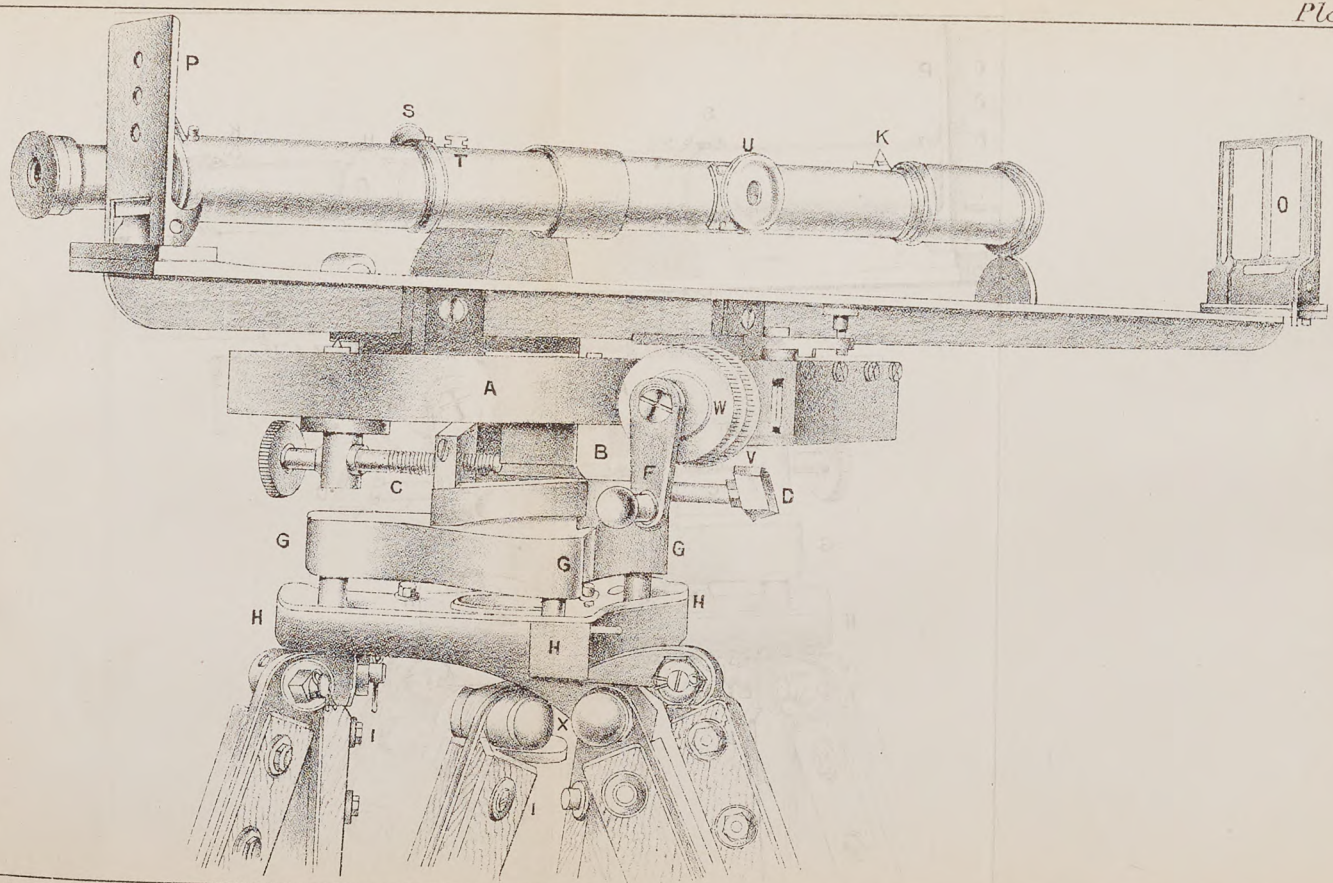

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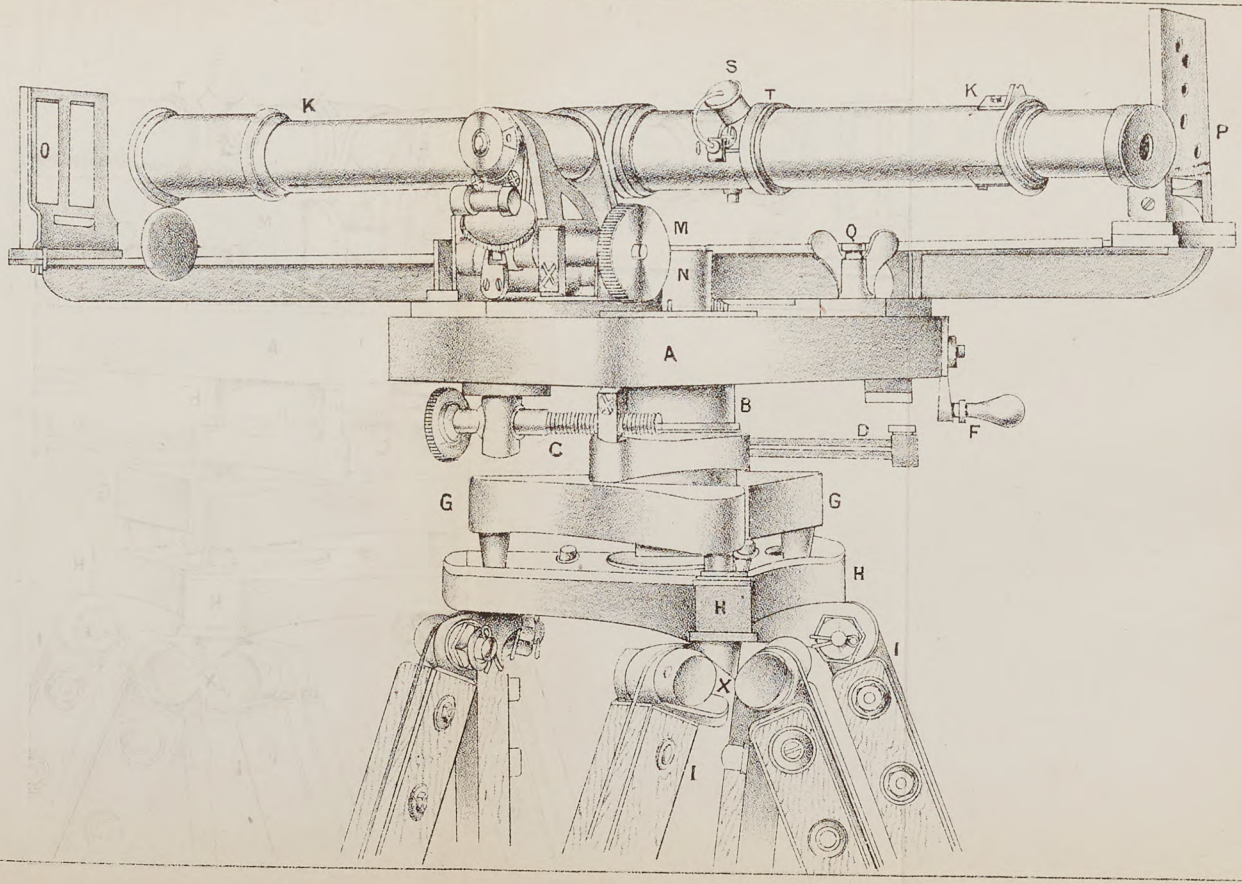

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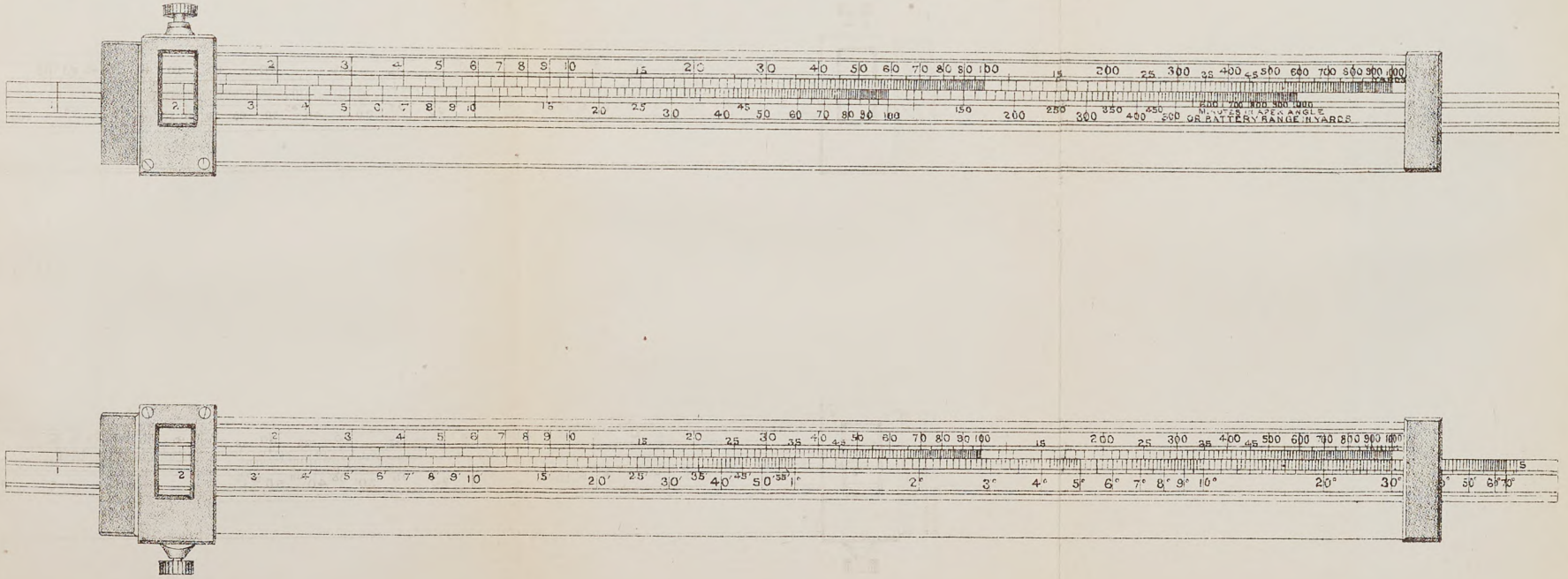

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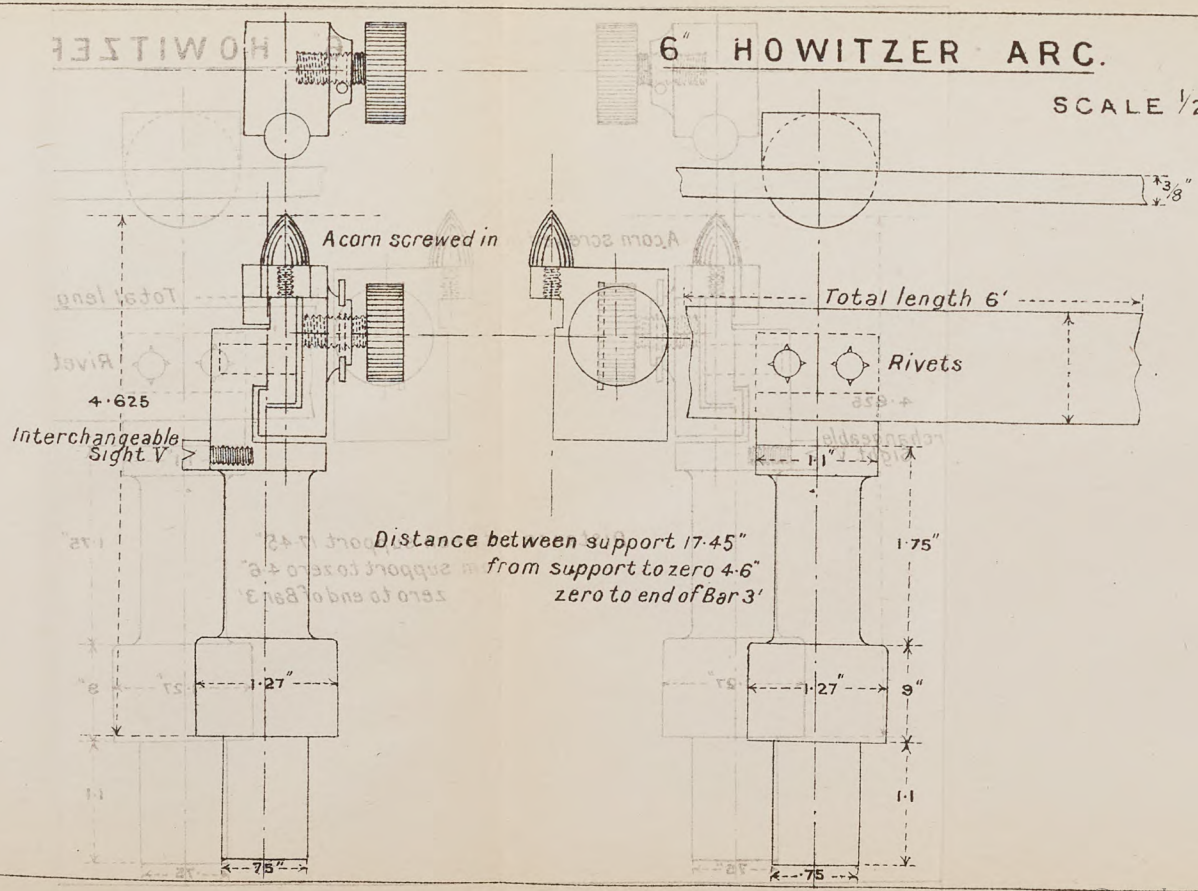

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